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(58) Field of Search

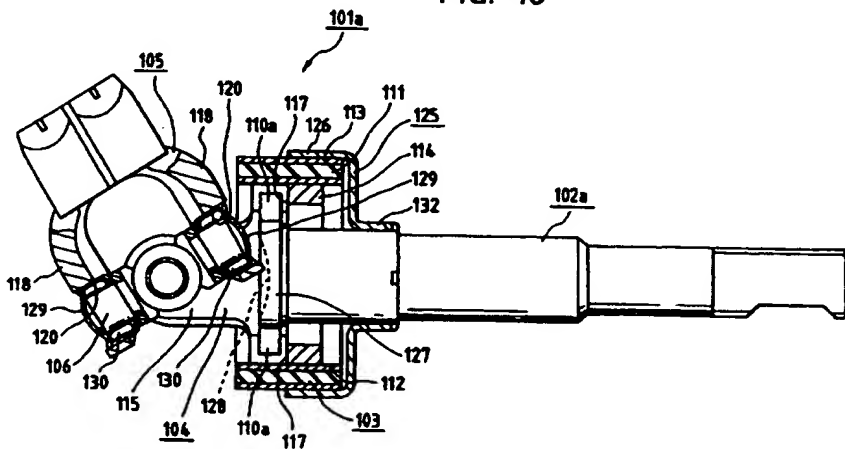
UK CL (Edition P) F2U  
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ON-LINE: WPI, JAPIO

(54) Abstract Title

Elastic universal joint assembly

(57) An elastic universal joint assembly for a vehicle steering gear comprises a joint yoke 104 having a cylindrical portion 114 which is connected to a shaft 102a through an elastic joint 103. The cylindrical portion 114 has notches 117 which loosely embrace lugs 110a, integral with or attached to the end of the shaft. The cylindrical portion 114 may be around the elastic joint rather than within it (Figs 1 to 12). A concave portion 128 in the end surface of the shaft prevents interference between the shaft and the other yoke 105 of the joint.

FIG. 16



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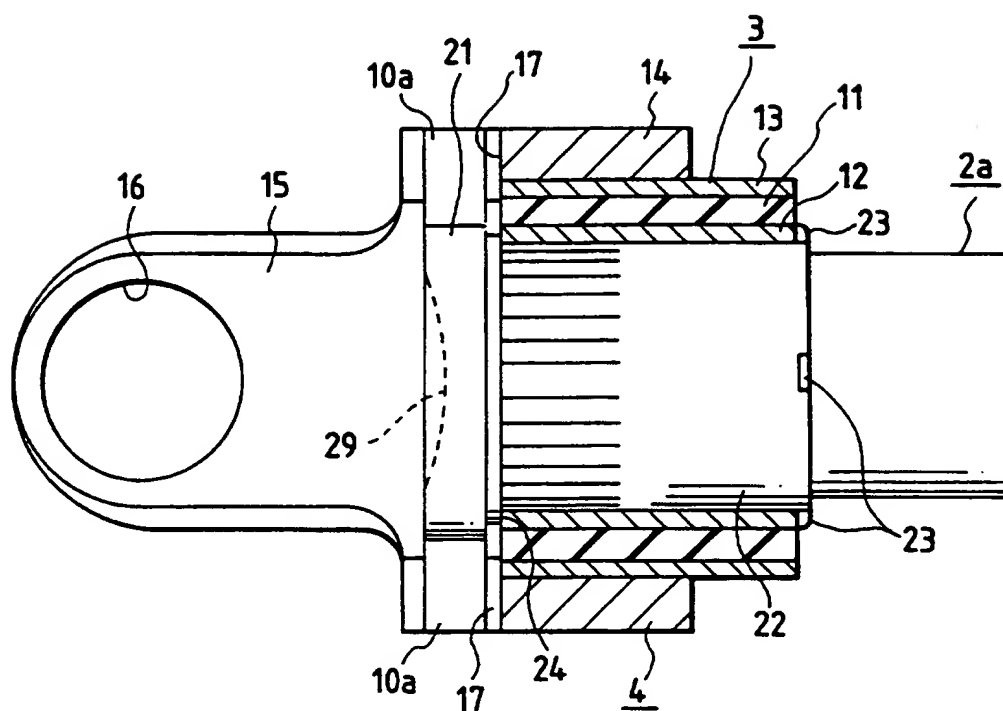


FIG. 3

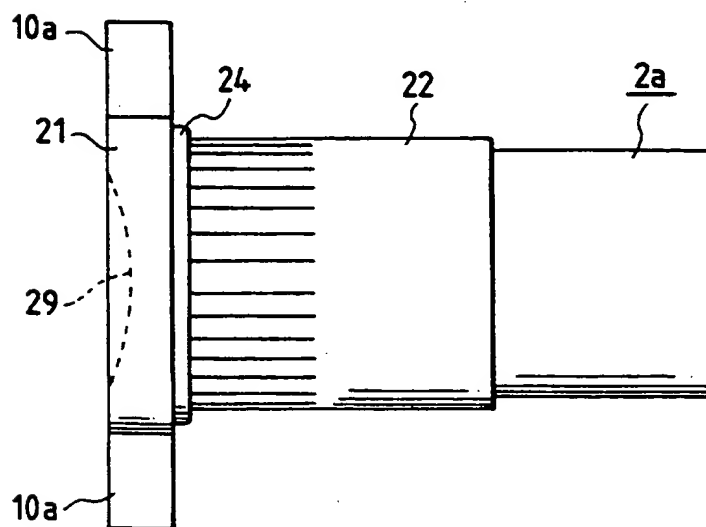


FIG. 4

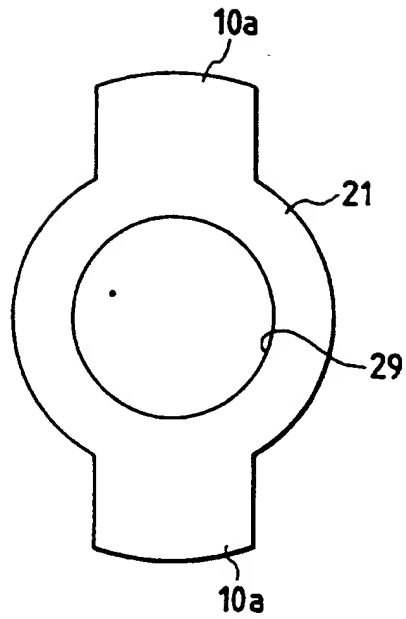


FIG. 5

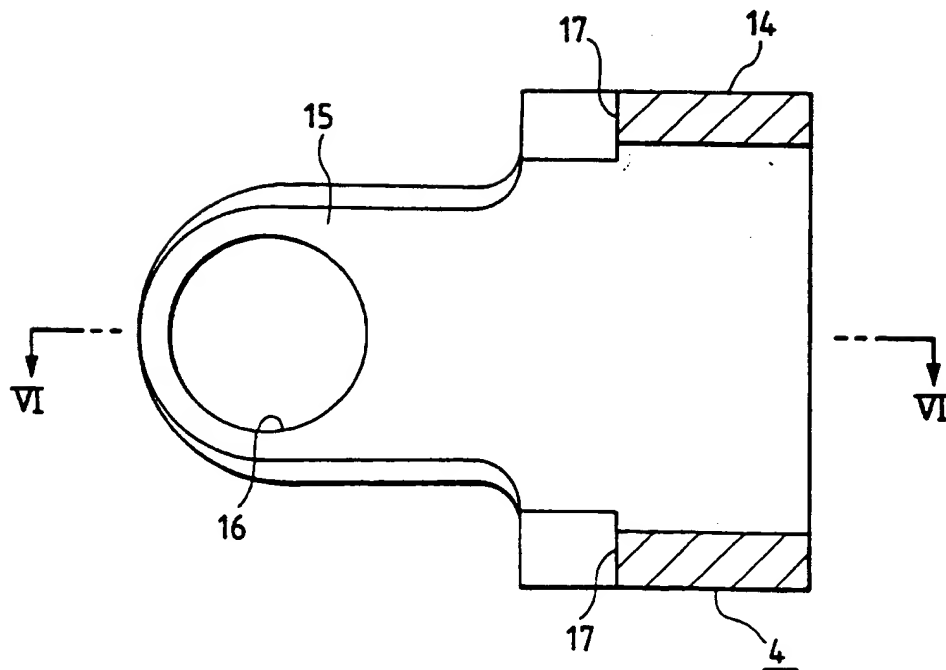


FIG. 6

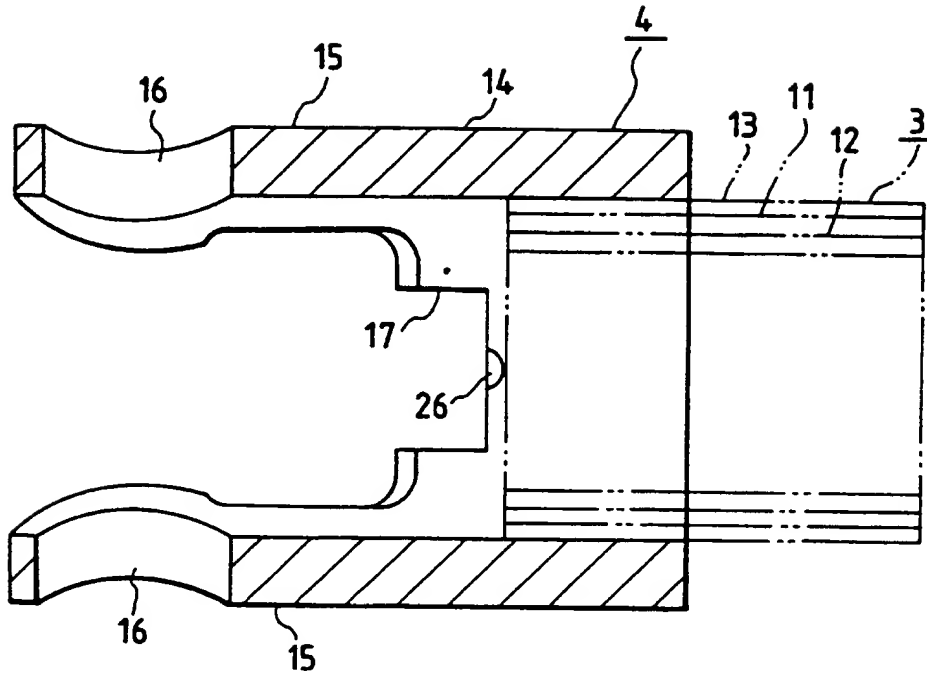


FIG. 7

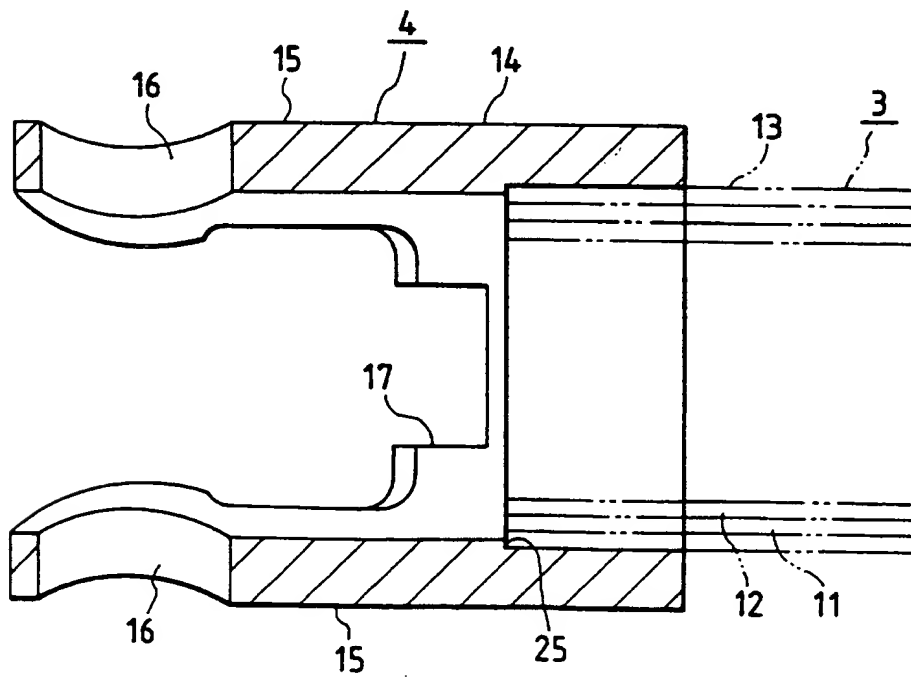


FIG. 8

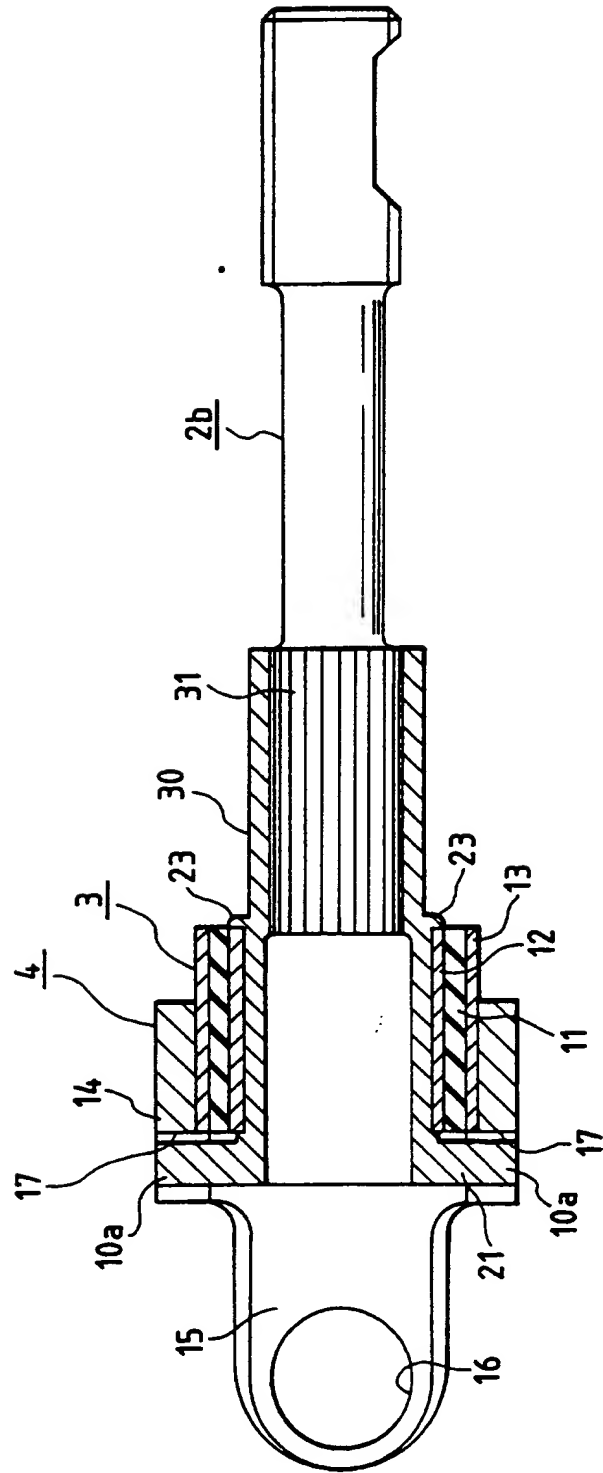


FIG. 9

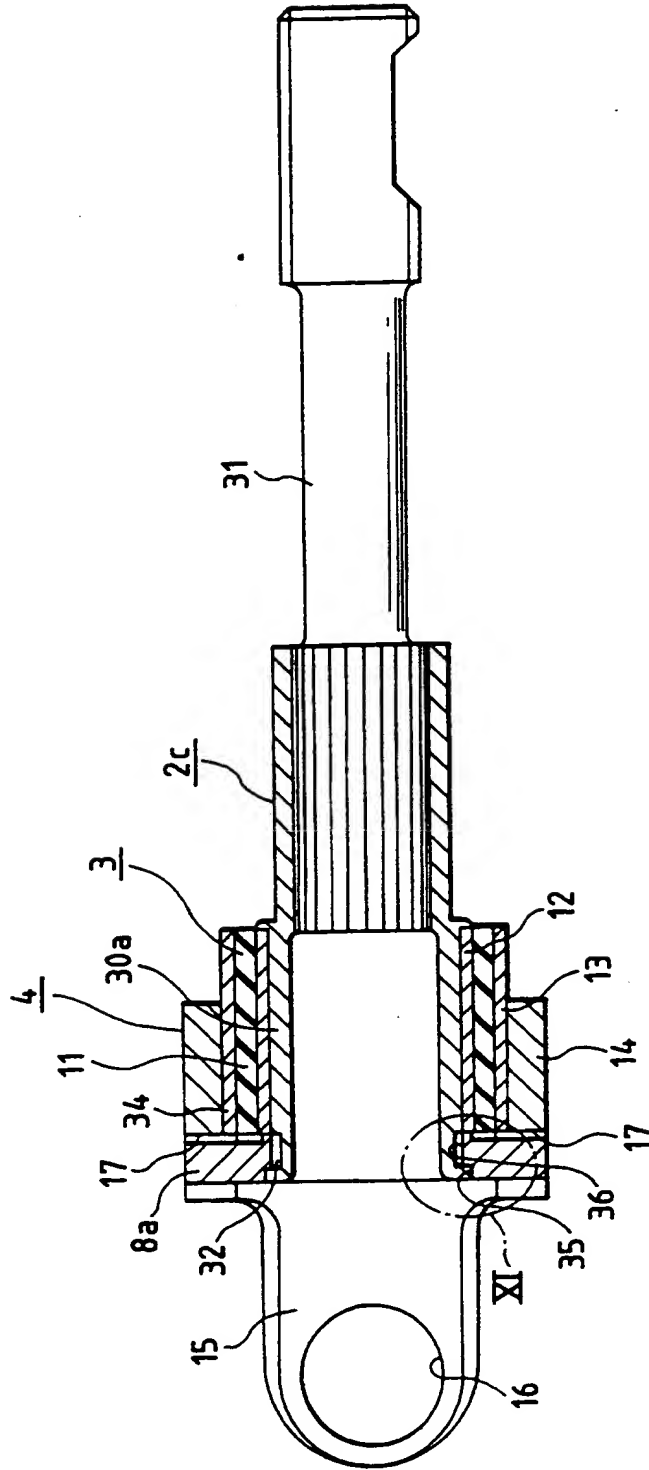


FIG. 10

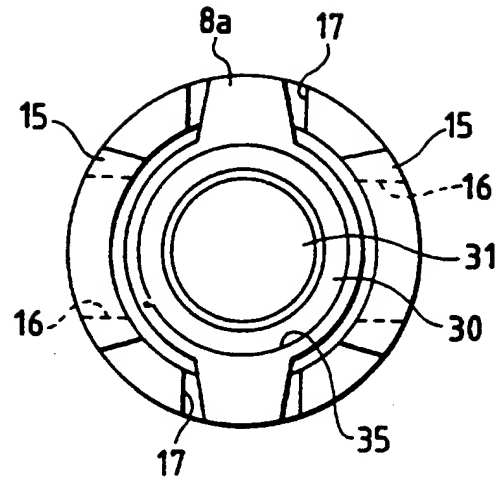


FIG. 11

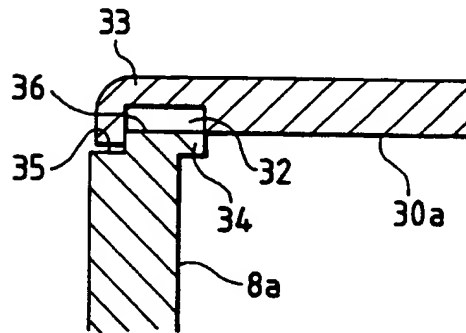


FIG. 12

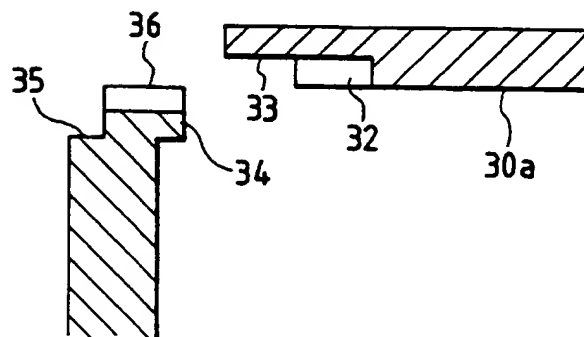
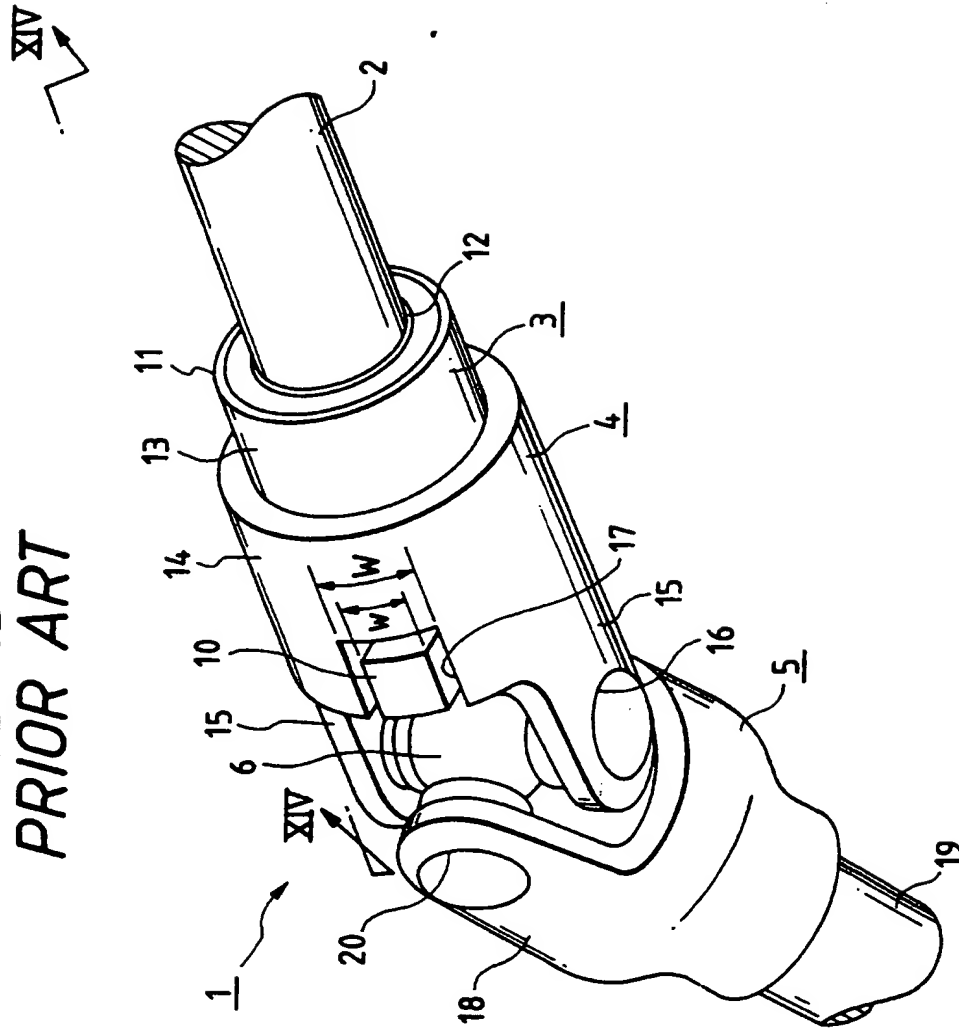
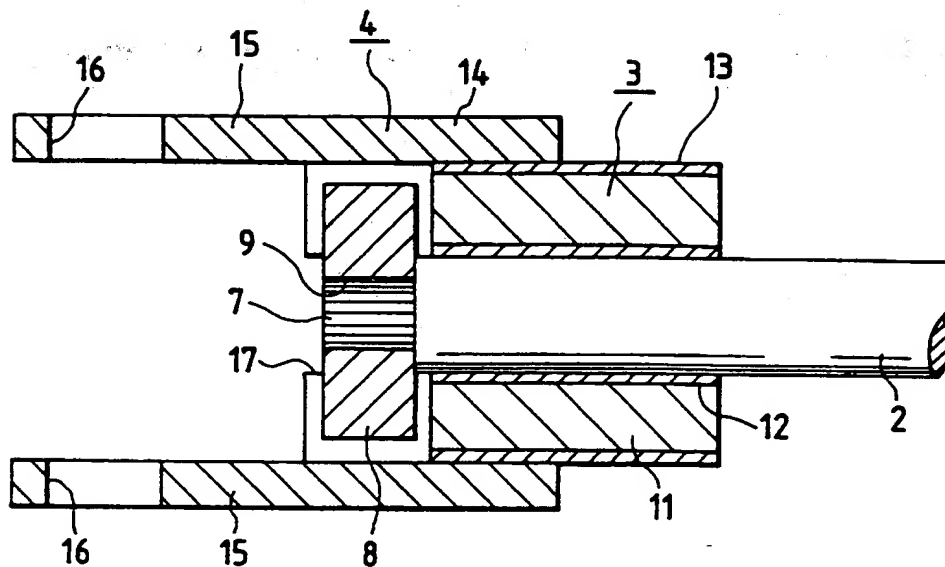




FIG. 13  
PRIOR ART



**FIG. 14**  
**PRIOR ART**



**FIG. 15**  
**PRIOR ART**

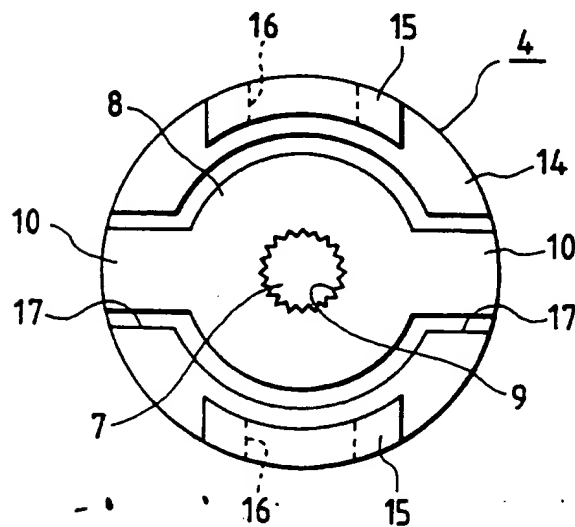
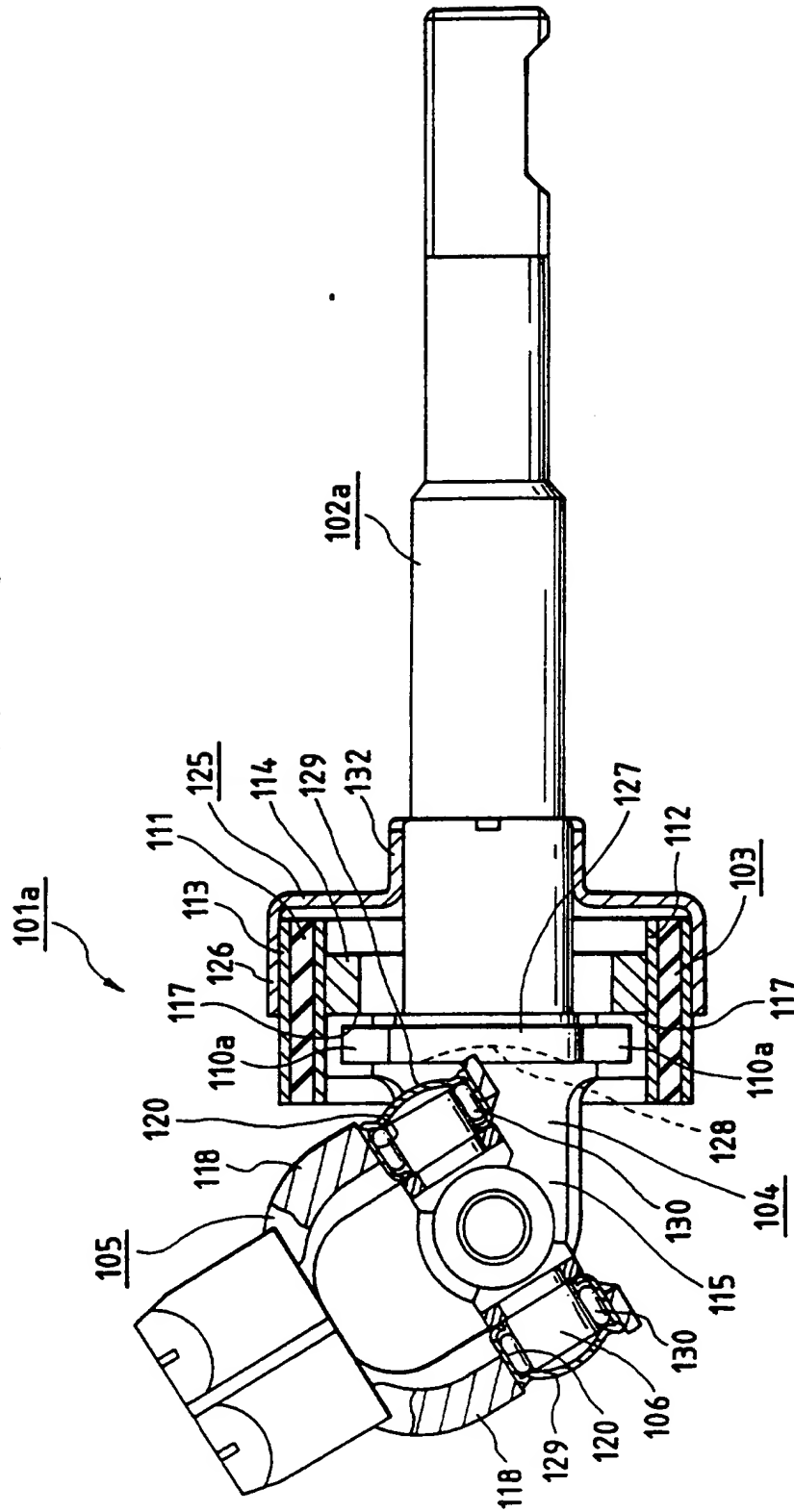


FIG. 16



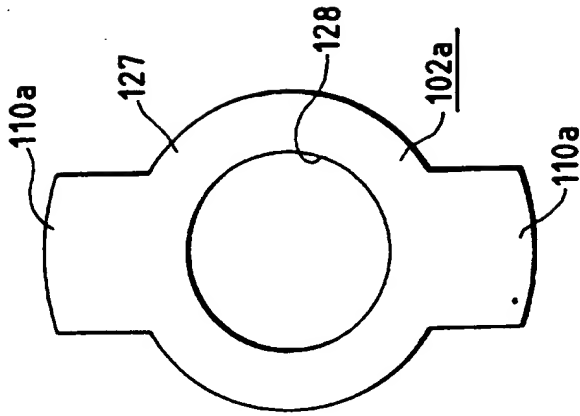
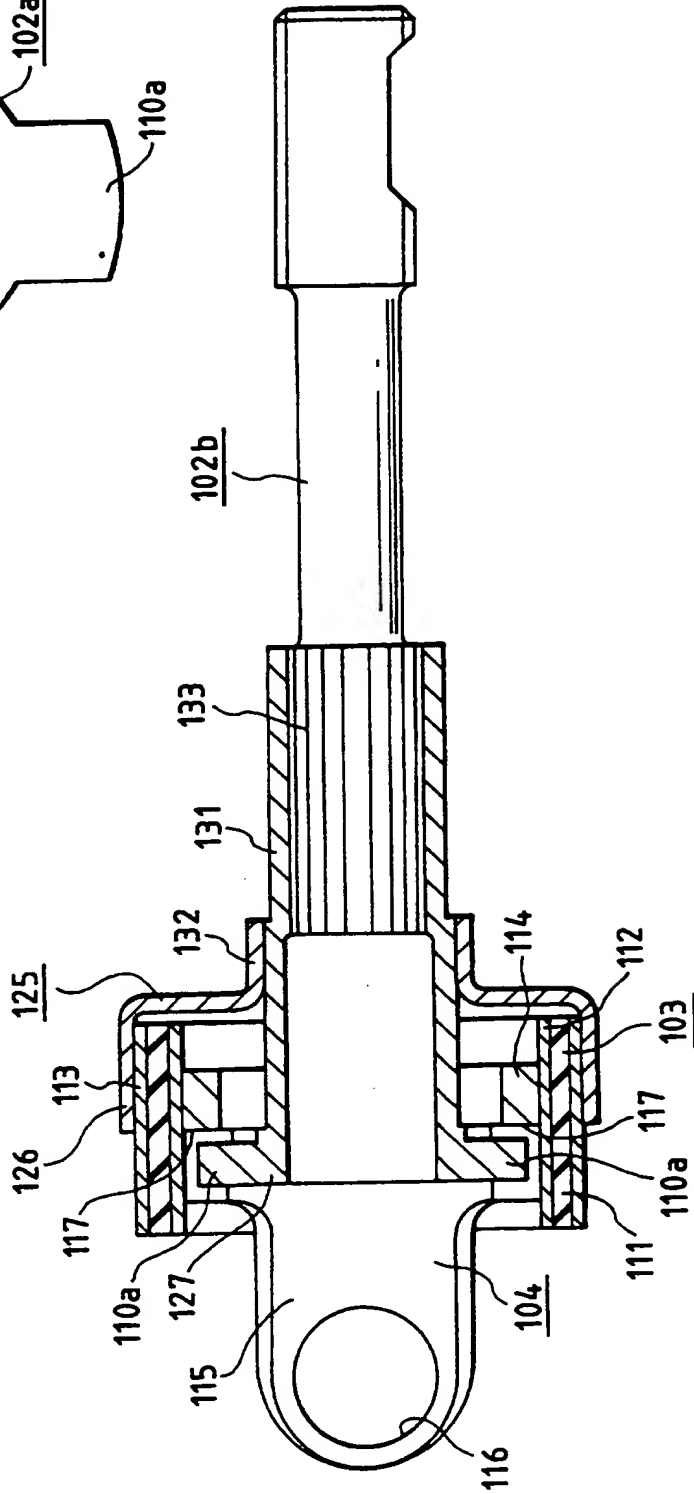
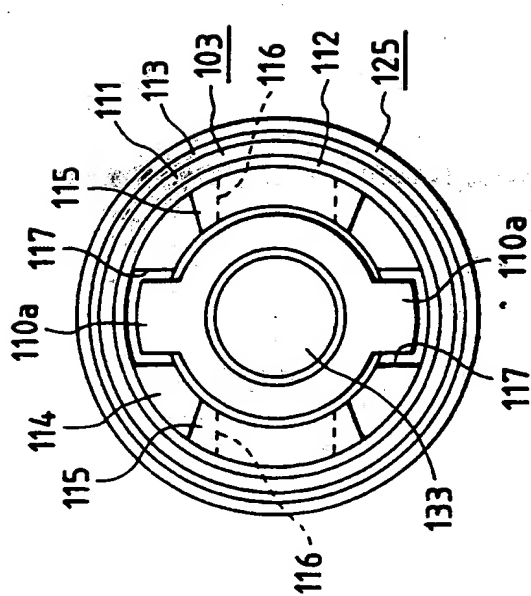


FIG. 17

FIG. 18





**FIG. 19**

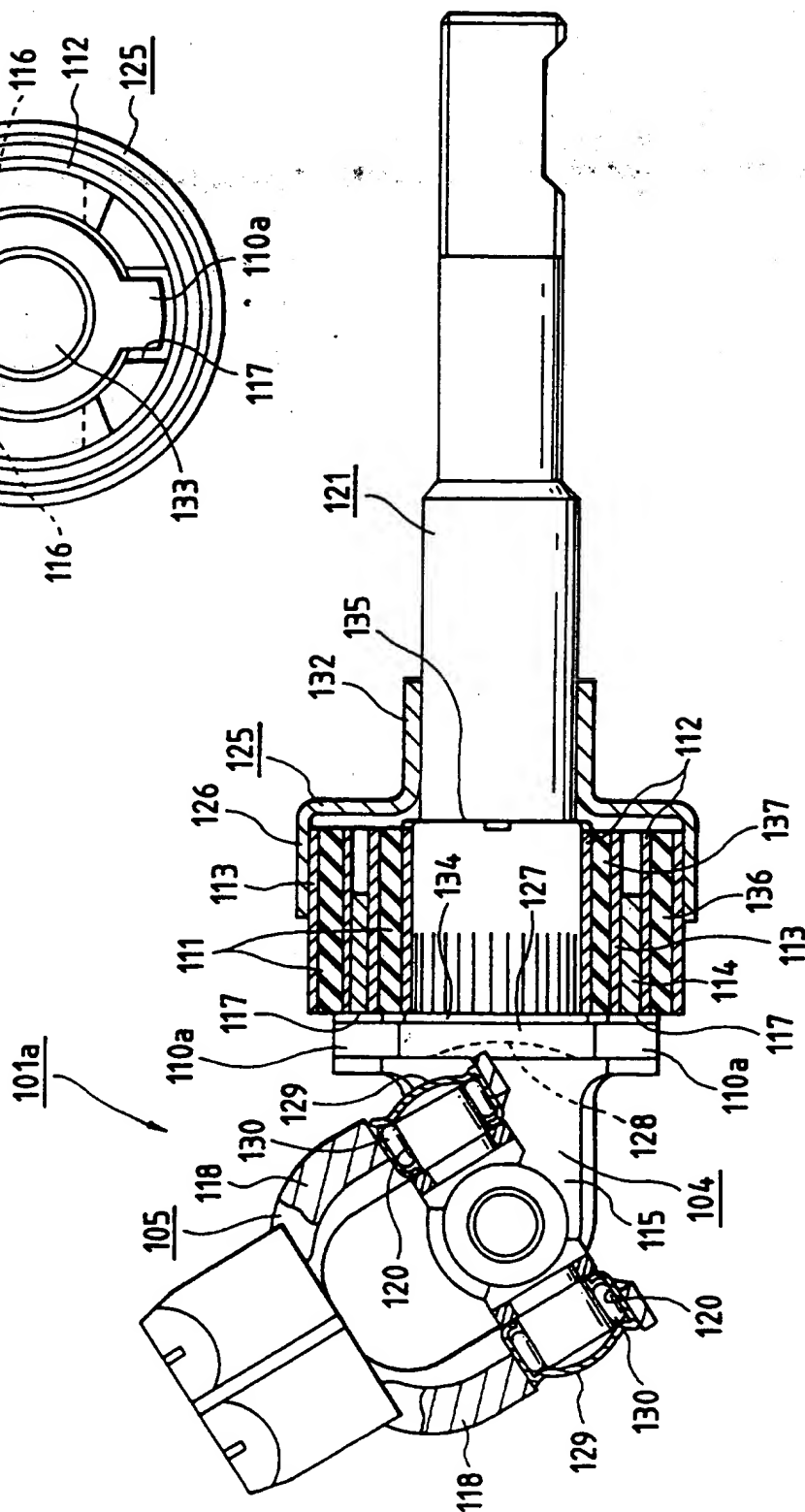


FIG. 20

FIG. 21

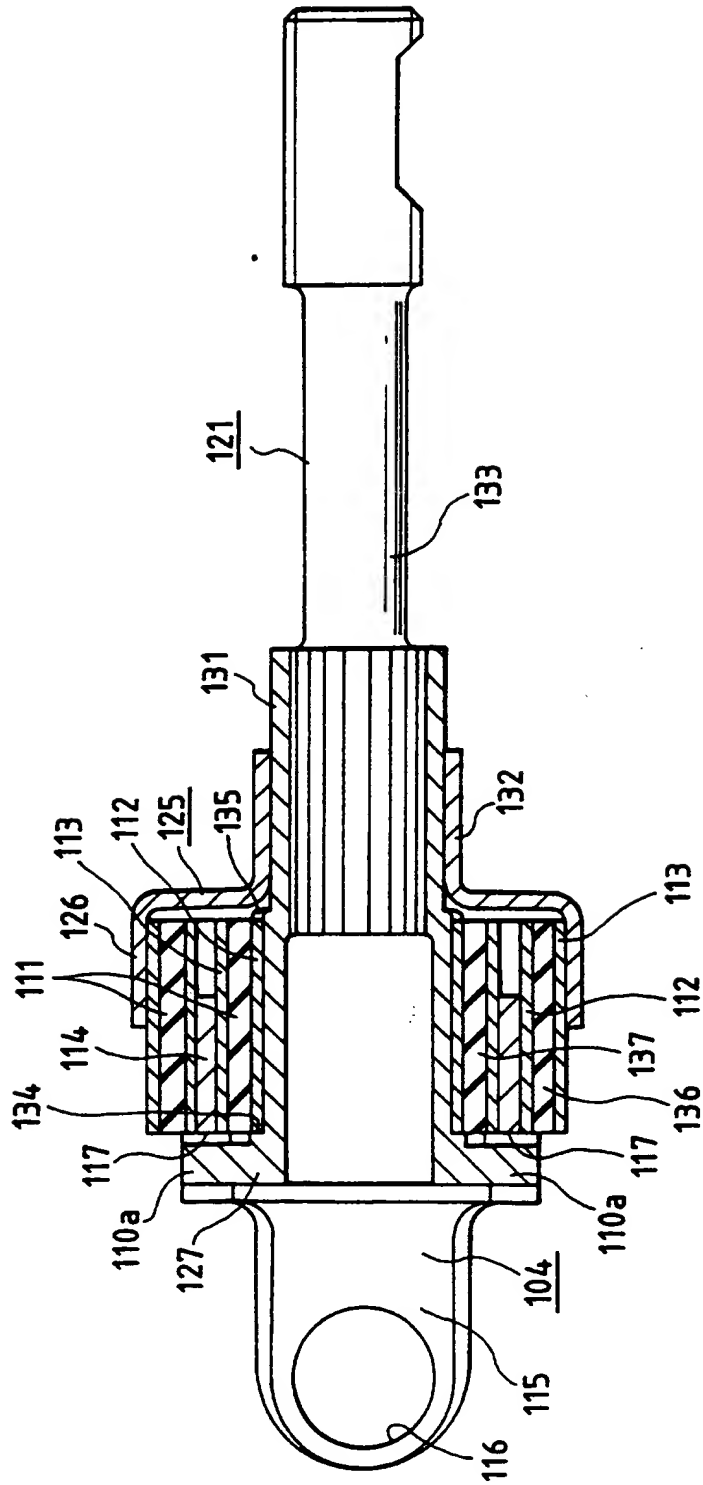


FIG. 22

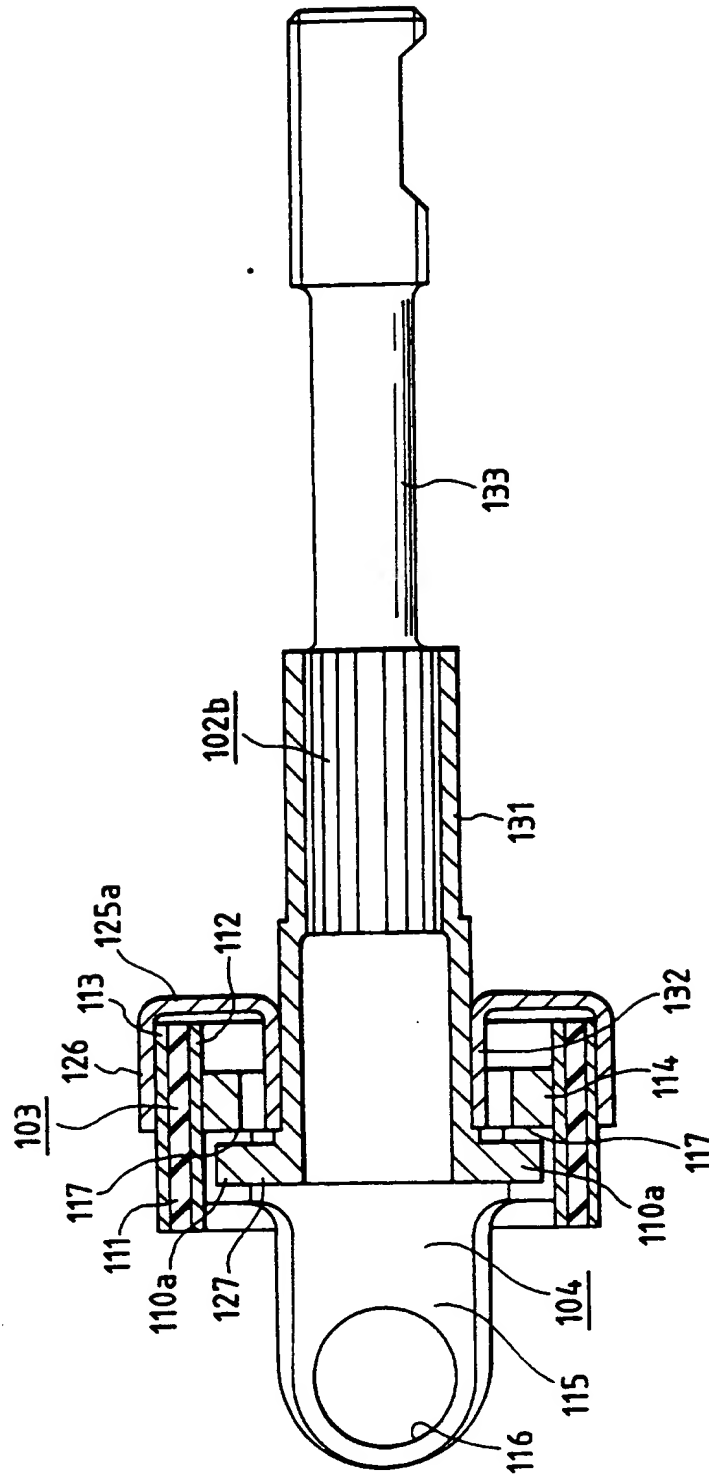
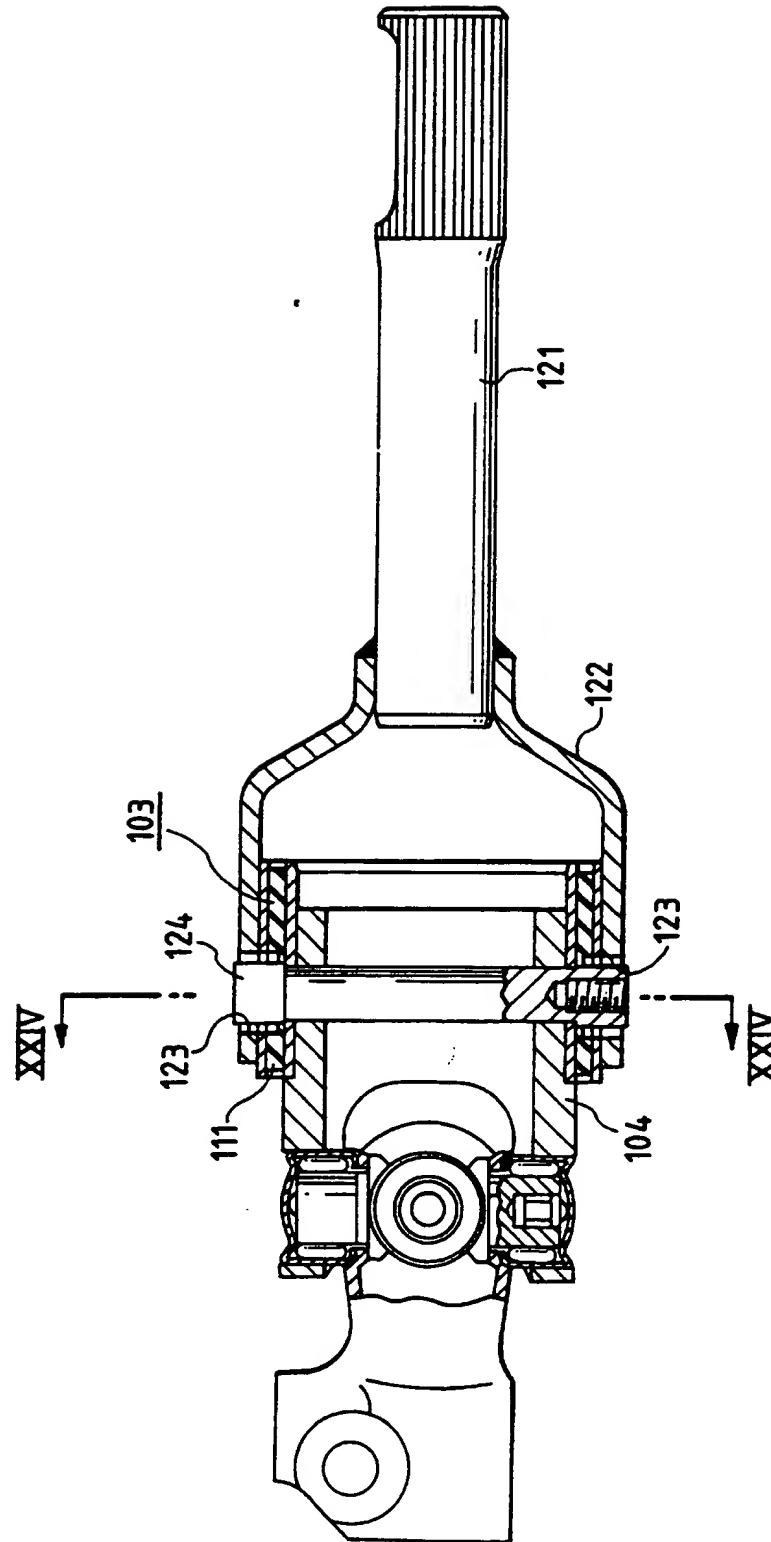
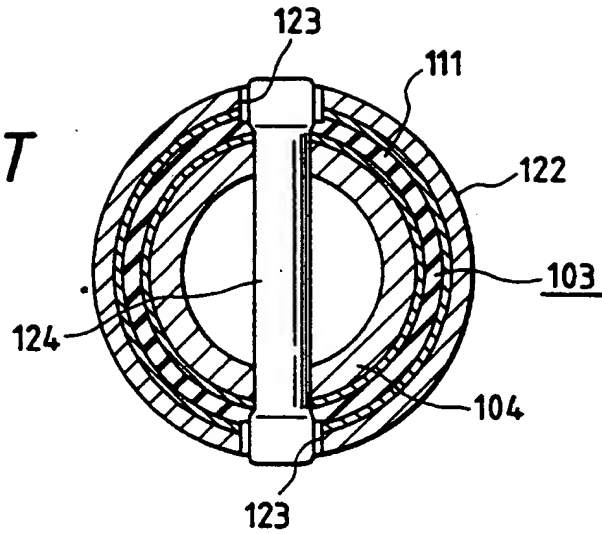


FIG. 23  
PRIOR ART

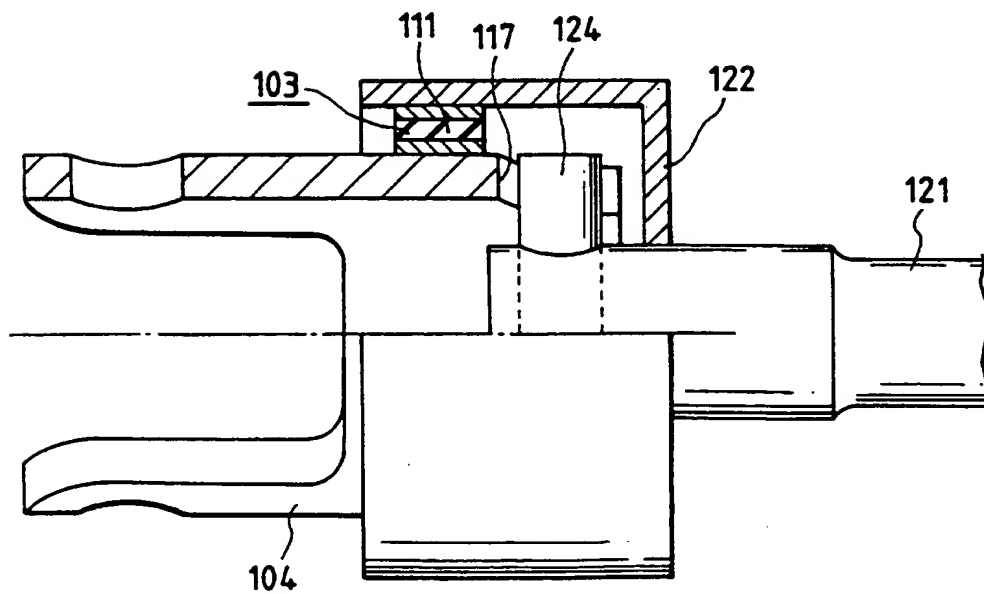




*FIG. 24*  
*PRIOR ART*



*FIG. 25*  
*PRIOR ART*



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ELASTIC UNIVERSAL JOINT

BACKGROUND OF THE INVENTION

Field of the Invention

5           The present invention relates to an elastic  
universal joint incorporated into a steering apparatus  
for an automobile and serving to make a motion of a  
steering wheel freely transmittable to a steering gear  
but serving to prevent vibrations of the steering gear  
10 from being transferred to the steering wheel.

Related Background Art

          The automobile steering apparatus is constructed  
to transmit a motion of a steering shaft rotationally  
driven by a steering wheel to a steering gear and to  
15 give a steering angle to a front wheel. It is common  
that the steering shaft and an input shaft of the  
steering gear can not be arranged on the same straight  
line. For this reason, a universal joint is provided  
between the steering shaft and the input shaft thereof,  
20 with the result that the motion of the steering wheel  
is freely transmittable to the steering gear. Further,  
it has hitherto been practiced that the universal joint  
was provided with a vibration absorbing ability to  
prevent a driver from undergoing jarring vibrations  
25 transmitted to the steering wheel via the steering gear  
from the wheels when the automobile would be running.  
Giving the vibration absorbing ability to the universal

joint typically involves the use of a so-called elastic universal joint constructed by incorporating an elastic material such as rubber, etc. into this universal joint enough to prevent the transmission of the vibrations with this elastic material.

Joints conventionally known as this type of elastic universal joints are disclosed in Japanese Patent Laid-Open Application No. 56-39325 (French Patent Laid-Open No. 2464404), Japanese Utility Model Laid-Open Application Nos. 54-82257, 5-83462 and 5-89964 and French Patent Laid-Open No. 2614985. Those conventionally known elastic universal joints have substantially the same structure, and hence a structure of the universal joint disclosed in Japanese Patent Laid-Open Application No. 5-89964 among them will be explained with reference to FIGS. 13 to 15.

This elastic universal joint 1, as illustrated in FIG. 13, includes a shaft 2, a first yoke 4 externally fixed to a front end (a left end in FIGS. 13 and 14) of this shaft 2 through a buffer drum 3a, second yoke 5 and a cross shaft 6 for connecting this second yoke 5 to the first yoke 4. A serration shaft 7 is, as depicted in FIGS. 14 and 15, formed at a portion protruding from one edge of the buffer drum 3 at the front end of the shaft 2. Then, this serration shaft 7 is serration-engaged with a central bore of a transmission member 8. Accordingly, this transmission

member 8 is fixedly provided at the front end of the shaft 2 and rotates together with this shaft 2.

Further, protruded segments 10, 10 protruding outward from the outer peripheral surface of the buffer drum 3 in the diametrical direction are integrally formed in two face-to-face positions in the diametrical direction on the circumference of this transmission member 8.

Among the respective members constituting the elastic universal joint 1, the buffer drum 3 is formed in a cylindrical shape including an elastic material 11 such as rubber, elastomer, etc.. That is, this buffer drum 3 is constructed of an internal sleeve 12 and an external sleeve 13 that are each composed of a metal in a cylindrical shape, and these sleeves 12, 13 are disposed concentrically with each other. Then, an outer peripheral surface of the internal sleeve 12 is connected to an inner peripheral surface of the elastic material 11 by baking or bonding, and an inner peripheral surface of the external sleeve 13 is similarly connected to an outer peripheral surface of the elastic material 11. Subsequently, the internal sleeve 12 is fixedly fitted to a front end of the shaft 2, and the external sleeve 13 is internally fixedly fitted to a cylindrical unit 14 which is provided to the first yoke 4 and will be mentioned later.

The first yoke 4 includes a pair of first arms 15, 15 extending in an axial direction from face-to-face

positions in a diametrical direction of one edge (a left edge in FIGS. 13 and 14) of this cylindrical unit 14 in the axial direction (right-and-left directions in FIGS. 13 and 14). Then, first circular holes 16, 16 are formed concentrically with each other in front edges (left edges in FIGS. 13 and 14) of the first arms 15, 15. Further, notches 17, 17 are formed in the face-to-face positions in the diametrical direction of one edge of the cylindrical unit 14 but in areas off the pair of first arms 15, 15. A width dimension  $W$  of each of those notches 17, 17 is larger than a width dimension  $w$  ( $W > w$ ) of each of the protruded segments 10, 10 of the transmission member 8. Then, in a state where the shaft 2 is assembled inwardly of the first yoke 4, the protruded segments 10, 10 are loosely engaged with the insides of the notches 17, 17 with gaps.

Further, the second yoke 5 includes a pair of second arms 18 spaced away from each other and fixedly connected to an end of another shaft 19. Second circular holes 20 are formed concentrically with each other in front edges of the second arms 18. Then, four edges of the cross shaft 6 are rotatably supported inwardly of the first and second circular holes 16, 20 provided by one pairs through bearings such as radial needle bearings.

The following is an operation of the thus

constructed elastic universal joint 1. When an automobile runs straight, or when a rotational torque applied to the shaft 2 from a steering wheel is small, the protruded segments 10, 10 of the transmission member 8 fixed to the front end of the shaft 2 exist in neutral positions or positions deviating a bit from the neutral positions inwardly of the notches 17, 17 formed in the cylindrical unit 14 of the first yoke 4. In each of those states, the cylindrical unit 14 does not directly contact the transmission member 8 at all. Further, the small rotational torque is transmitted from the shaft 2 via the buffer drum 3 to the first yoke 4. In this case, the elastic material 11 constituting the buffer drum 3 absorbs the vibrations transferred from the wheels to the first yoke 4 via the steering gear, another shaft 19, the second yoke 5 and the cross shaft 6, with the result that the vibrations are not transmitted to the shaft 2.

In contrast with this, when the rotational torque applied to the shaft 2 from the steering wheel is larger as in the case of giving a large steering angle to the front wheel, the respective protruded segments 10, 10 impinge on the inner surfaces of the notches 17, 17. As a result, a large proportion of the rotational torque applied from the steering wheel to the shaft 2 is transmitted via the transmission member 8 to the first yoke 4. In this state, the rotational torque

transmitted via the buffer drum 3 is limited.

Accordingly, even if the rotational torque transmitted via the elastic universal joint 1 increases, there is eliminated such a possibility that an excessive force  
5 acts on the elastic material 11 constituting the buffer drum 3 enough to damage this elastic material 11.

Further, Japanese Patent Laid-Open Application No. 4-42924 discloses an elastic universal joint as shown in FIGS. 23 and 24. The elastic universal joint  
10 disclosed in this Publication aims at securing both of a steering stability and a vibration attenuating performance. In this elastic universal joint, circular holes 123, 123 are formed in face-to-face positions in a diametrical direction in a front edge of a housing  
15 member 122 fixedly welded to the end portion of the shaft 121. Then, a proximal end portion of the first yoke 104 is internally fixedly fitted in the inside of a buffer drum 103 internally fixedly fitted in the front edge of the housing member 122. Further, both  
20 edges of a pin 124 penetrating the proximal end portion of the first yoke 104 in the diametrical direction are loosely fitted in the circular holes 123, 123.

In the case of the thus constructed elastic universal joint shown in FIGS. 23 and 24, the small  
25 rotational torque is transmitted between the shaft 121 and the first yoke 104 via the elastic material 111

constituting the buffer drum 103. Further, when transmitting the large rotational torque, external peripheral surface of two edges of the pin 124 impinge on internal circumferences of the circular holes 123, 123, thereby transmitting the torque via this pin 124.

Moreover, Japanese Patent Laid-Open Application No. 6-329033 discloses an elastic universal joint structured as illustrated in FIG. 25. In the elastic universal joint disclosed in this Publication, both ends of the pin 124 fixed to the edge of the shaft 121 are loosely engaged with notches 117 formed in a rear edge of the first yoke 104. Further, the buffer drum 103 is interposed between the inner peripheral surface of the housing member 122 including its proximal end fixed to the shaft 121 and the outer peripheral surface of an intermediate portion of the first yoke 104.

In the case of the thus constructed elastic universal joint shown in FIG. 25, the small rotational torque is transmitted between the shaft 121 and the first yoke 104 via the elastic material 111 constituting the buffer drum 103. Moreover, when transmitting the large rotational torque, the outer peripheral surfaces of the both ends of the pin 124 impinge on the inner edges of the notches 117, thereby transmitting the torque via this pin 124.

In the case of the conventional elastic universal joint constructed as shown in FIGS. 13 to 15, the



following problems arise in terms of attaining both downsizing and a reduction in weight. To be specific, if an intersecting angle between central axes of a couple of shafts 2, 19 connected to each other via the elastic universal joint 1 is large, with rotations of these two shafts 2, 19, the second yoke 5 largely swings about one shaft constituting the cross shaft 6. Then, as a result of this swing, the front edge of the second arm 18 constituting the second yoke 5, as illustrated in FIG. 1 representative of an embodiment of the present invention, approaches the front end surface of the shaft 2 (corresponding to a shaft 2a in FIG. 1) while depicting a circular-arc locus about one shaft.

There is almost no case in which the intersecting angle of the elastic universal joint increases as shown in FIG. 1 in an ordinary using state. However, securing the intersecting angle that is as large as shown in FIG. 1 is required in terms of protecting a driver when collided. That is, in the event that the front of the automobile is crushed by an accident of collision, the steering wheel is prevented from being thrust against the driver, and hence it is a common practice that part of a plurality of shafts constituting a steering apparatus is bendable while absorbing an impact energy in the event of the accident of collision. Then, if part of the shaft is bent, the

intersecting angle of the elastic universal joint provided at the end of the relevant shaft exceeds the state shown in FIG. 1 and reaches approximately 90 degrees. Accordingly, securing the large intersecting angle is needed in terms of protecting the driver by making part of the shaft smoothly bendable.

Under such circumstances, the elastic universal joint 1 is required to incorporate such a function that the front edge of the second arm 18 does not interfere with the front end surface of the shaft 2 even in a state where the front edge thereof comes closest to the front end surface thereof. For preventing such an interference, the second yoke 5 and the shaft 2 have hitherto been spaced far away from each other. More specifically:

(1) the first arms 15, 15 of the first yoke 4 are elongated, and the front edge is spaced far away from the front end surface of the shaft 2 by moving the cross shaft 6 leftward in FIGS. 13 and 14, about which the second arm 18 swings; or alternatively,

(2) the cylindrical unit 14 of the first arm 4 is elongated, and the front end surface of the shaft 2 is spaced far away from the second arm 16 by moving the buffer drum 3 and the shaft 2 rightward in FIGS. 13 and 14.

By the way, in each of these items (1) and (2), a dimension of the first yoke 4 in the axial direction

increases, and this is undesirable because of bringing about rises both in size and weight of the elasticuniversal joint 1.

5 In the case of the conventional elastic universal joint, it is difficult to attain both securing the steering stability and the vibration attenuating performance and downsizing with a smaller weight. Specifically, in the case of the structure illustrated in FIGS. 13 to 15, the weight thereof can be decreased,  
10 but securing both the steering stability and the vibration attenuating performance is difficult. That is, an enhancement of the torsional rigidity of the elastic material 11 to secure the steering stability involves increasing the diameter of this elastic  
15 material 11 or increasing the hardness of the elastic material 11. In the case of the structure shown in FIGS. 13 to 15, however, the buffer drum 3 including the elastic material 11 is fixedly fitted in the inside of the first yoke 4, and, therefore, the torsional  
20 rigidity is hard to enhance with an increased diameter of the elastic material 11. Further, if the elastic material 11 has the increased hardness, it follows that the vibration attenuating performance is deteriorated.

Moreover, in the case of the structure shown in  
25 FIGS. 23 and 24, even when the steering stability and the vibration attenuating performance can be secured, it is difficult to reduce the weight. Specifically, in

the case of the structure illustrated in FIGS. 23 and 24, the small or large torque is transmitted via the housing member 122, and hence it is required that the rigidity of the housing member 122 be well increased.

5 Accordingly, a plate thickness of the housing member 122 has to sufficiently increase, and a weight of the housing member 122 inevitably rises. Moreover, it is troublesome to form the circular holes matching with each other in the housing member 122, the buffer drum 103 and the first yoke 104 (or to match the circular 10 holes previously formed in the respective members 122, 103, 104), resulting in a drop in terms of a productivity of the elastic universal joint.

Further, in the case of the structure illustrated 15 in FIG. 25, it is also difficult to attain both securing the steering stability and the vibration attenuating performance and decreasing the weight. Specifically, in the case of the structure shown in FIG. 25, the buffer drum 103 and the engaged portions 20 of the two edges of the pin 124 with the notches 117 are so provided as to deviate in the axial direction. Accordingly, if the dimension of the buffer drum 103 in the axial direction is elongated to secure the steering stability and the vibration attenuating performance by 25 increasing a volume of the elastic material 111 constituting the buffer drum 103, the elastic universal joint increases in size with the result that the weight

also rises. Reversely, for downsizing the elastic universal joint and decreasing the weight thereof, the dimension of the buffer drum 103 in the axial direction is reduced. In this case, the elastic material 111  
5 lacks its volume, and it is impossible to secure both the steering stability and the vibration attenuating performance.

#### SUMMARY OF THE INVENTION

10 It is a primary object of the present invention to provide an elastic universal joint contrived to attain downsizing and a reduction in weight thereof while sufficiently securing functions.

15 It is another object of the present invention to provide a practicable elastic universal joint capable of attaining both securing a steering stability and a vibration attenuating performance and reducing the weight.

20 An elastic universal joint according to the present invention satisfies all the following requirements (1) - (8).

(1) The elastic universal joint comprises an elastic universal joint comprising a shaft, a first yoke externally fixed fitted to a front end of the  
25 shaft through a buffer drum, a second yoke and a cross shaft for connecting the second yoke to the first yoke.

(2) A protruded segment more protruded outward in

a diametrical direction than an outer peripheral surface of the buffer drum is fixedly provided on a portion protruding from one edge of the buffer drum at a front end of the shaft.

5           (3) The buffer drum is formed in a cylindrical shape including an elastic material.

          (4) The first yoke has a cylindrical member, a pair of first arms extending in an axial direction from face-to-face positions in a diametrical direction of one edge of the cylindrical member in the axial direction, a pair of circular holes formed concentrically with each other in front edges of the first arms and notches formed at one edge of the cylindrical member in the axial direction but in areas off the pair of first arms.

10

15

          (5) The second yoke has a pair of second arms spaced away from each other and a pair of second circular holes formed concentrically with each other in front edges of the second arms.

20           (6) Four edges of the cross shaft are rotatably supported inwardly of the first and second circular holes respectively formed by one pairs.

          (7) The protruded segment fixedly provided at the front end of the shaft is loosely engaged with the notch formed in the cylindrical member of the first yoke with a gap.

25

          (8) A concave portion or a hole is formed in a

central portion of a front end surface of the shaft.

The thus constructed elastic universal joint has the same operations when the rotational torque is transmitted between a pair of shafts disposed on a non-  
5 straight line and when preventing a transfer of vibrations as those of the conventional elastic universal joint described above. Especially in the case of the elastic universal joint of the present invention, the concave portion or the hole is formed in  
10 the central portion of the front end surface of the shaft, and, correspondingly, even when a distance between this front end surface and the second yoke is reduced, a front edge of the second arm does not interfere with the front end surface of the shaft.  
15 Accordingly, the first yoke is not required to increase its size in order to prevent the interference, thereby making it possible to downsize the elastic universal joint and to decrease its weight.

An elastic universal joint according to the other  
20 present invention satisfies the following requirements (1) - (7).

(1) The elastic universal joint comprises a shaft, a coupling bracket having its proximal end portion fixedly connected to a close-to-front-end area of an  
25 intermediate portion of the shaft, a first yoke internally fitted and supported inwardly of an external cylindrical member provided at a front edge of the

coupling bracket through a buffer drum, a second yoke and a cross shaft for connecting the first and second yokes to each other.

5 (2) A protruded segment more protruded outward in a diametrical direction than an outer peripheral surface of the shaft is fixedly provided on a portion positioned inward in the diametrical direction of the buffer drum at a front end of the shaft, the protruded segment having its edge facing to an inner peripheral  
10 surface of the buffer drum.

(3) The buffer drum is formed in a cylindrical shape including an elastic material.

(4) The first yoke has an internal cylindrical member internally fixedly fitted in said buffer drum, a  
15 pair of first arms extending in an axial direction from face-to-face positions in a diametrical direction of one edge of the internal cylindrical member in the axial direction, a pair of circular holes formed concentrically with each other in front edges of the  
20 first arms and notches formed at part of one edge of the internal cylindrical member in the axial direction but in areas off the pair of first arms and existing inward in the diametrical direction of the buffer drum.

(5) The second yoke has a pair of second arms  
25 spaced away from each other and a pair of second circular holes formed concentrically with each other in front edges of the second arms.



(6) Four edges of the cross shaft are rotatably supported inwardly of the first and second circular holes respectively formed by one pairs.

5 (7) The protruded segment fixedly provided at the front end of the shaft is loosely engaged with the notch formed in the internal cylindrical member of the first yoke with a gap.

An elastic universal joint according to the further present invention meets all the following  
10 requirements (a) - (g).

(a) The elastic universal joint comprises a shaft, a coupling bracket having its proximal end portion fixedly connected to a close-to-front-end area of an intermediate portion of the shaft, a first yoke  
15 supported through internal and external buffer drums between the inside of an external cylindrical member provided at the front edge of the coupling bracket and an outer peripheral surface of the front end of the shaft, a second yoke and a cross shaft for connecting  
20 the first and second yokes to each other.

(b) A protruded segment more protruded outward in a diametrical direction than an outer peripheral surface of the internal buffer drum is fixedly provided on a portion protruding from one edge of at least the  
25 internal buffer drum at a front end of the shaft.

(c) The two internal and external buffer drums are formed in a cylindrical shape each including an elastic material.

(d) The first yoke has an internal cylindrical member, a pair of first arms extending in the axial direction from face-to-face positions in a diametrical direction of one edge of the internal cylindrical member in the axial direction, a pair of first circular holes formed concentrically with each other in front edges of the first arms and notches formed at part of one edge of the internal cylindrical member in the axial direction but in areas off the pair of first arms, the internal cylindrical member being internally fitted and supported inwardly of the external cylindrical member through the external buffer drum but externally fitted and supported at the front end of the shaft.

(e) The second yoke has a pair of second arms spaced away from each other and a pair of second circular holes formed concentrically with each other in front edges of the second arms.

(f) Four edges of the cross shaft are rotatably supported inwardly of the first and second circular holes respectively formed by one pairs.

(g) The protruded segment fixedly provided at the front end of the shaft is loosely engaged with the notch formed in the internal cylindrical member of the first yoke with a gap.

Further, in the elastic universal joint according to the present invention, preferably, a concave portion

or a hole is formed in the central portion of the front end surface of the shaft.

The thus constructed elastic universal joint has the same operations when the rotational torque is transmitted between the pair of shafts disposed on the non-straight line and when preventing the transfer of the vibrations as those of the conventional elastic universal joint described above. Especially in the case of the elastic universal joint claimed in claim 1 among the elastic universal joints of the present invention, the buffer drum is externally fixedly fitted to the internal cylindrical member of the first yoke, and hence a diameter of this buffer drum can be sufficiently increased. Further, the elastic universal joint claimed in claim 2 is provided with the two internal and external buffer drums, and, therefore, a volume of the elastic materials constituting the buffer drums can be increased. As a result, even when particularly the hardness of the elastic material is not enhanced, the steering stability can be enhanced by increasing the torsional rigidity of the buffer drum.

Furthermore, the coupling bracket including the external cylindrical member in which the buffer drum is internally fixedly fitted transmits not the large rotational torque but only the small rotational torque. The large rotational torque is transmitted through no intermediary of the coupling bracket by such an

arrangement that the protruded segment fixed to the front end of the shaft engages with the notch of the internal cylindrical member constituting the first yoke. The coupling bracket is not therefore required to have a particularly large rigidity. For this reason, the coupling bracket is thinned, thereby making it possible to reduce the weight of the elastic universal joint.

Especially in the case of the elastic universal joint of the present invention, the engaged portion between the protruded segment and the notch exists inwardly of the buffer drum, and, hence, even when securing the length of the buffer drum in the axial direction in order to ensure the volume of the elastic material, the length of the elastic universal joint in the axial direction is not elongated, with the result that the weight of the elastic universal joint can be reduced. Further, the elastic universal joint of the present invention includes the internal and external buffer drums provided dually. It is therefore feasible to secure the volume of the elastic material without increasing the length of the buffer drum in the axial direction and to reduce the weight of the elastic universal joint without increasing the length of the elastic universal joint in the axial direction.

Moreover, the concave portion or the hole is formed in the central portion of the front end surface

of the shaft, and, in this case, even when decreasing a distance between the front end surface and the second yoke in proportion to the formation of the concave portion or the hole in the central portion of the front end surface of the shaft, the front edge of the second arm does not interfere with the front end surface of the shaft. Accordingly, there is eliminated the necessity for increasing the size of the first yoke to prevent the interference, and the elastic universal joint can be downsized with a smaller weight.

#### BRIEF DESCRIPTION OF THE DRAWINGS

Other objects and advantages of the present invention will become apparent during the following discussion in conjunction with the accompanying drawings, in which:

FIG. 1 is a side view with some portion cut away, illustrating a first embodiment of the present invention;

FIG. 2 is an enlarged view of the left part in FIG. 1 but illustrates a cross shaft and a second yoke with some omissions;

FIG. 3 is a view illustrating only a front end portion of a shaft taken out of FIG. 2;

FIG. 4 is a diagram as viewed from left in FIG. 3;

FIG. 5 is a view illustrating only a first yoke taken out of FIG. 2;

FIG. 6 is a sectional view taken substantially along the line VI-VI of FIG. 5;

FIG. 7 is a view similar to FIG. 6 but illustrates an example of a configuration disadvantageous in terms of manufacturing costs;

FIG. 8 is a side view with some portion cut away, showing a second embodiment of the present invention;

FIG. 9 is a side view with some portion cut away, showing a third embodiment of the present invention;

FIG. 10 is a diagram as viewed from left in FIG. 9;

FIG. 11 is an enlarged view of a XI portion in FIG. 9 but illustrates an engaged portion between the front end of an outer shaft and a transmission member in an as-engaged state;

FIG. 12 is an enlarged view of the XI portion in FIG. 9 but similarly illustrates the same engaged portion in a pre-engagement state;

FIG. 13 is a perspective view illustrating one example of a conventional structure;

FIG. 14 is a sectional view taken substantially along the line XIV-XIV of FIG. 13, showing the cross shaft and the second yoke with some omissions;

FIG. 15 is a diagram as viewed from left in FIG. 14;

FIG. 16 is a side view with some portions cut away, showing a fourth embodiment of the present

invention;

FIG. 17 is a diagram as viewed from left in FIG. 16, illustrating only the front end of the shaft taken out of FIG. 16;

5        FIG. 18 is a side view with some portions cut away, illustrating the cross shaft and the second yoke with some omissions in a fifth embodiment of the present invention;

10       FIG. 19 is a diagram as viewed from left in FIG. 18;

FIG. 20 is a side view with some portions cut away, showing sixth embodiment of the present invention;

15       FIG. 21 is a partially cut-away side view showing the cross shaft and the second yoke with some omissions in a seventh embodiment of the present invention;

FIG. 22 is a partially cut-away side view showing the cross shaft and the second yoke in an eighth embodiment of the present invention;

20       FIG. 23 is a partially cut-away side view illustrating a second example of the conventional structure;

FIG. 24 is a sectional view taken substantially along the line XXIV-XXIV of FIG. 23; and

25       FIG. 25 is a partially cut-away side view illustrating a third example of the conventional structure.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

FIGS. 1 to 7 illustrate a first embodiment of the present invention. An elastic universal joint 1a according to the present invention includes, as  
5 illustrated in FIG. 1, a shaft 2a, a first yoke 4 externally fixedly fitted to a front end (a left end in FIGS. 1 and 2) of this shaft 2a through a buffer drum 3, a second yoke 5 and a cross shaft 6 for connecting the second yoke 5 to the first yoke 4. A collar-like  
10 transmission member 21 assuming a shape as shown in FIG. 4 is formed integrally with the shaft 2a by a proper working method such as cold forging working, etc. at a portion protruding from one edge (a left edge in FIGS. 1 and 2) at the front end of the shaft 2a.  
15 Further, protruded segments 10a, 10a protruding outward in the diametrical direction from an outer peripheral surface of the buffer drum 3 are integrally formed in two face-to-face positions in the diametrical direction on the outer circumference of this transmission member  
20 21.

A concave portion 29 is, as illustrated in FIGS. 1 and 4, formed at the central portion of the transmission member 21 that may be also conceived as the central portion on the front end surface of the  
25 shaft 2a. In the case of the illustrative embodiment, this concave portion 29 has a spherical concave surface including its opening taking a circular shape.



Accordingly, this concave portion 29 is deepest at its central area but gradually becomes shallower as it approaches the circumference.

5 Further, the above buffer drum 3 is, as in the same way with the conventional structure described above, formed in the cylindrical shape as a whole in such an arrangement that an outer peripheral surface of an internal sleeve 12 is connected to an inner peripheral surface of an elastic material 11 by baking  
10 or bonding, and an inner peripheral surface of an external sleeve 13 is similarly connected to an outer peripheral surface of the elastic material 11. Then, the internal sleeve 12 is externally fixedly fitted to the front end portion of the shaft 2a, while the  
15 external sleeve 13 is internally fixedly fitted in a cylindrical unit 14 which is attached to the first yoke as will be mentioned later.

Note that the front end portion of the shaft 2a is formed with a large-diameter portion 22 having a larger  
20 outer diametrical dimension than other portions exclusive of the above transmission member 21 and a stepped portion 24 formed on a proximal portion (a right edge in FIGS. 1 to 3) of this transmission member 21. Then, a fine rugged area is formed on part of the  
25 outer peripheral surface of this large-diameter portion 22 by knurling. When the above buffer drum 3 is externally fixedly fitted to the front end portion of

the shaft 2a, the shaft 2a is inserted into the internal sleeve 12 of this buffer drum 3 from the proximal portion (the right side in FIG. 1) of this shaft 2a, and the internal sleeve 12 is externally fitted to the large-diameter portion 22 with a sufficient fastening allowance. Further, a front edge (a right edge in FIGS. 1 and 2) of the internal sleeve 12 impinges on the stepped portion 24, and, in this state, a proximal edge (a right edge in FIGS. 1 to 3) of the large-diameter portion is caulking-expanded outward in the diametrical direction, thereby forming caulked portions 23, 23. Then, these caulked portions 23, 23 engage with the proximal edge (the right edge in FIGS. 1 and 2) of the internal sleeve 12. In this state, both of the edges of the internal sleeve 12 in the axial direction (the right-and-left direction in FIGS. 1 and 2) engage with the caulked portions 23, 23 as well as with the stepped portion 24, thus hindering a movement along the axial direction.

In the case of the illustrative embodiment, effects itemized (a), (b) as follows are obtained by providing the fine rugged area, the stepped portion 24 and the caulked portions 23, 23.

(a) It is possible to surely prevent the buffer drum 3 from sliding on the shaft 2a.

(b) Positioning for externally fitting the buffer drum 3 to the shaft 2a is relatively easy.

The explanation starts with the item (a) of these items (a), (b). The shaft 2a including the transmission member 21 is manufactured by, e.g., the cold forging working, and, in which case a draft (working degree) is high. Hence, it is a common practice to perform pre-processing by use of a metal soap before a forming process. For this reason, a coefficient of friction on the obtained surface of the shaft 2a decreases, and the internal sleeve 12 is easy to slide on the large-diameter portion 22 in the peripheral direction and the axial direction as well if the internal sleeve 12 is simply externally fitted to the internal sleeve.

Contrastingly, in the case of the illustrative embodiment, the fine rugged area formed by the knurling serves to increase the coefficient of friction between the outer peripheral surface of the large-diameter portion 22 and the inner peripheral surface of the internal sleeve 12. It is therefore possible to prevent the internal sleeve especially from sliding on the shaft 2a in the peripheral direction. Further, the two edges of the internal sleeve 12 engage with the stepped portion 24 and the caulked portions 23, 23, thereby preventing the movement along the axial direction. Hence, it is also feasible to prevent this internal sleeve from sliding on the shaft 2a in the axial direction.

Next, the item (b) will be explained. The buffer drum 3 prevents vibrations of the external sleeve 13 fixed to the first yoke 4 from being transmitted up to the internal sleeve 12 fixed to the shaft 2a by interposing the elastic material 11 between the internal sleeve 12 and the external sleeve 13. It is therefore required that each of the constructive members be assembled so as not to make the external sleeve 12 contact with the transmission member 21 fixed to the shaft 2a. In the case of the above-described conventional structure, it is required that the operation be performed while regulating a press-fitting quantity of the internal sleeve 12 with respect to the shaft 2a (FIGS. 13 and 14). The press-fitting operation is troublesome, and, besides, a scatter in the press-fitting quantity is easy to occur. The scatter in terms of the press-fitting quantity leads directly to a scatter in dimension of an elastic universal joint in the axial direction and is therefore undesirable in terms of stabilizing a quality of the product. Such a problem is obviated by such an arrangement that the front edge (the left edge in FIGS. 1 and 2) of the internal sleeve 12 is more protruded in the axial direction than the front edge (the left edge in FIGS. 1 and 2) of the external sleeve 13. Instead, however, there arise problems in which a directivity is produced in the case of assembling the buffer drum 3,

and both of the assembling operation and the manufacturing operation of the buffer drum 3 are troublesome.

Contrastingly in the case of the illustrative  
5 embodiment, if the internal sleeve 12 is externally fitted to the large-diameter portion 22 of the shaft 2a till the front edge of the internal sleeve 12 impinges on the stepped portion 24, the press-fitting quantity of this internal sleeve 12 can be regulated, and a  
10 contact between the external sleeve 13 and the transmission member 21 can be prevented. For this reason, an anti-vibration effect can be surely obtained without making the assembling operation of the buffer drum 3 troublesome or increasing the manufacturing  
15 costs.

On the other hand, the first yoke 4 includes, as illustrated in FIGS. 5 and 6, a cylindrical unit 14 defined as a cylinder member and a pair of first arms 15, 15 formed at one edge (a left edge in FIGS. 1, 2, 5  
20 and 6) of the cylindrical unit 14 in the axial direction (the right-and-left directions in FIGS. 1, 2, 5 and 6) and extending in the axial direction from face-to-face positions in the diametrical direction. Then, first circular holes 16, 16 are formed  
25 concentrically with each other in front edges (left edges in FIGS. 1, 2, 5 and 6) of the first arms 15, 15. Further, notches 17, 17 are respectively formed in

areas off the pair of first arms 15, 15 in face-to-face positions of one edge portion of the cylindrical unit 14 in the axial direction. Dimensions of widths of these notches 17, 17 are larger than dimensions of widths of the protruded segments 10a, 10a of the transmission member 21. Then, in a state where the shaft 2a is assembled inwardly of the first yoke 4, the respective protruded segments 10a, 10a loosely engage with the insides of the notches 17, 17 with some gaps.

Further, in the case of the illustrative embodiment, the internal peripheral surface of the cylindrical unit 14 is not provided with a stepped portion 25 as shown in FIG. 7 but formed as a simple cylindrical surface wherein a minor diameter does not change along the axial direction. Instead, a caulked protruded segment 26 is, as illustrated in FIG. 6, formed by caulk-bending the edge central portion of each notch 17 inward in the diametrical direction. The external sleeve 13 of the buffer drum 3 is internally fitted in the cylindrical unit 14, and, in this state, the front edge of this external sleeve 13 impinges on the caulked protruded segment 26, thereby positioning the external sleeve 13 with respect to the first yoke 4. The operation of forming the above caulked protruded segment 26 is easier than the operation of forming the above stepped portion 25 (FIG. 7), and, correspondingly, a reduction in the costs for

manufacturing the first yoke 4 and the elastic universal joint 1a is attained.

Furthermore, the second yoke 5 is made by press-working, e.g., a thick metal plate and includes a pair of second arms 18, 18 spaced away from each other. The thus constructed second yoke 5 is fixedly joined to an edge of another shaft 19 (see FIG. 13) by tightly fastening an unillustrated bolt. Second circular holes 20, 20 are respectively formed concentrically with each other in front edges (a right downward portion in FIG. 1) of the second arms 18, 18. Then, four edges of the cross shaft 6 are rotatably supported on the internal areas of the two first and second circular holes 16, 20 formed by one pair through radial needle bearings 28, 28 constructed including bearing cups 27, 27.

An operation of the thus constructed elastic universal joint 1a is as follows. When an automobile runs straight, or when a rotational torque applied to the shaft 2a from a steering wheel is small, the protruded segments 10a, 10a of the transmission member 21 fixed to the front end of the shaft 2a exist in neutral positions or positions deviating a bit from the neutral positions inwardly of the notches 17, 17 formed in the cylindrical unit 14 of the first yoke 4. Then, in each of those states, the cylindrical unit 14 does not directly contact the transmission member 21 at all. Further, the small rotational torque is transmitted

from the shaft 2a via the buffer drum 3 to the first yoke 4. In this case, the elastic material 11 constituting the buffer drum 3 absorbs the vibrations transferred from the wheels to the first yoke 4 via the steering gear, another shaft 19, the second yoke 5 and the cross shaft 6, with the result that the vibrations are not transmitted to the shaft 2a.

In contrast with this, when the rotational torque applied to the shaft 2a from the steering wheel is larger as in the case of giving a large steering angle to the front wheel, the respective protruded segments 10a, 10a impinge on the inner surfaces of the notches 17, 17. As a result, a large proportion of the rotational torque applied from the steering wheel to the shaft 2a is transmitted via the transmission member 21 to the first yoke 4. In this state, the rotational torque transmitted via the buffer drum 3 is limited. Accordingly, even if the rotational torque transmitted via the elastic universal joint 1a increases, there is eliminated such a possibility that an excessive force acts on the elastic material 11 constituting the buffer drum 3, thereby preventing this elastic material 11 from being damaged.

Further, in the case of the elastic universal joint 1a, because of the existence of the concave portion 29 formed in the front end surface of the shaft 2a, even when decreasing a distance between this front



end surface and the second yoke 5, the front edge of the second arm 18 constituting the second yoke 5 does not interfere with the front end surface of the shaft 2a. That is, when the second yoke 5 swings about the cross shaft 6, the front edge of the second arm 18 approaches the above front end surface while depicting a circular-arc locus about the cross shaft 6. The front edge described above comes closest to the front end surface, and, in this state, the central portion of the front end surface faces to the front edge. In the case of the elastic universal joint of the present invention, because of the existence of the concave portion 29 at the central portion of the front end surface, the front end surface is hard to interfere with the front edge. Accordingly, there is not necessity for increasing a size of the first yoke 4 in order to prevent the interference, and the elastic universal joint 1a can be downsized with a smaller weight. In other terms, it is possible to make the second yoke 5 approach the shaft 2a, corresponding to a depth of the concave portion 29, and the downsizing of the first yoke 4 is thereby attainable. Then, with this downsizing, an entire length of the first yoke 4 decreases, and a moldability of molding this first yoke 4 by drawing is improved, resulting in a reduction in terms of working costs.

Next, FIG. 8 illustrates a second embodiment of

the present invention. The second embodiment adopts a so-called collapsible shaft, wherein an entire length of a shaft 2b fixedly connecting the first yoke 4 to the front edge thereof (the left edge in FIG. 8) is reduced when undergoing an impact. Therefore, in accordance with the second embodiment, the shaft 2b is constructed so that an outer shaft 30 taking an annular tube-like shape and an inner shaft 31 assuming an annular rod-like shape are slidably combined.

Accordingly, a proximal half portion (a right half portion in FIG. 8) of the outer shaft 30 has a smaller diameter than a front half portion (a left half portion in FIG. 8), and a female serration groove is formed in an internal peripheral surface of this proximal half portion. Further, a front edge (a left edge in FIG. 8) of the inner shaft 31 has a larger diameter than other portions, and a male serration groove is formed on an outer peripheral surface of this front edge thereof, with the result that the male serration groove engages with the female serration groove. Further, a friction adjusting member composed of a synthetic resin, etc. is provided at part of the engaged portion between those serration grooves and is formed to slide in the axial direction (right-and-left directions in FIG. 8) only when the engaged portion between the two serration grooves undergoes a large impact concomitant with an accident of collision.

In the case of this embodiment, the outer shaft 30 constituting the front half portion of the shaft 2b takes the annular tube-like shape, and the front end of this outer shaft 30 is opened to the front end surface of the shaft 2b. Accordingly, the existence of the internal space defined as a concave portion or a hole serves to prevent the interference between the front edge of the second arm 18 (FIG. 1) constituting the second yoke 5 and the front end surface of the outer shaft 30, and, correspondingly, the first yoke 4 can be downsized with the smaller weight. Other configurations and operations are the same as those in the first embodiment.

Next, FIGS. 9 to 12 illustrate a third embodiment of the present invention. In both of the first and second embodiments discussed above, the transmission member 21 is formed integrally with each of the front ends of the shafts 2a, 2b (the transmission member 21 is formed integrally with the front end of the outer shaft 30 in the second embodiment). In contrast with this, the third embodiment takes such an arrangement that a transmission member 8a formed separately from an outer shaft 30a is fixedly connected to a front end (a left end in FIG. 9) of the outer shaft 30a constituting a shaft 2c based on a collapsible structure.

More specifically, in the case of the third embodiment, a male serration groove 32 is formed on an

outer peripheral surface of the front end of the outer shaft 30a, and, further, a front edge protruding from this male serration groove 32 is formed as a thin wall portion whose outer diametrical dimension becomes  
5 smaller. On the other hand, an inner circumferential area of the transmission member 8a is formed respectively with a ring-like protrusion 34 provided along the entire periphery of one side thereof but extending in the axial direction (a right direction in  
10 FIGS. 9, 11 and 12) and a ring-like recessed portion 35 provided in the other side thereof (a left surface in FIGS. 9, 11 and 12). Further, a female serration groove 36 is also formed in the inner circumferential area of the transmission member 8a.

15 A fixed connection of the transmission member 8a to the front end of the outer shaft 30a involves engaging the male serration groove 32 with the female serration groove 36 by directing the ring-like protrusion 34 toward an inner part of the male  
20 serration groove 32. Then, after the engagement therebetween, the above thin wall portion 33 is expanded outward in the diametrical direction and pressed against the ring-like recessed portion 35. As a result, the outer shaft 30a is fixed connected to the  
25 transmission member 8a in an inseparable manner. Furthermore, the ring-like protrusion 34 impinges on the front edge (the left edge in FIG. 9) of the inner

sleeve 12 of the buffer drum 3 protruding in the axial direction, thus preventing a contact between the front edge (the left edge in FIG. 9) of the outer sleeve 13 and the transmission member 8a. Other configurations and operations are the same as those in the second embodiment discussed above.

The elastic universal joint according to the present invention, which is constructed and operates as described above, is therefore capable of downsizing the elastic universal joint with the smaller weight while keeping such a function as to sufficiently increase the bending angles of the shafts connected to each other through the elastic universal joint.

FIGS. 16 and 17 illustrate a fourth embodiment of the present invention. An elastic universal joint 10 according to the present invention, as shown in FIG. 16, includes a shaft 102a and a coupling bracket 125 having its proximal end fixedly connected to a close-to-top-end area (a close-to-left area in FIG. 16) of an intermediate portion of the shaft 102a. The elastic universal joint 101a also includes a first yoke 104 internally fixedly fitted to the inside area of an external cylindrical member 126 provided at the front edge of the coupling bracket 125 through a buffer drum 103, a second yoke 105 and a cross shaft 106 for connecting this second yoke 105 to the first yoke 104. Further, a collar-like transmission member 127 taking a

configuration as shown in FIG. 17 is formed integrally with the shaft 102a by a proper working method such as cold forging working, etc. in an area positioned inward in the diametrical direction of the buffer drum 103 at the front end of the shaft 102a. Further, protruded segments 110a, 110a are integrally formed in two face-to-face positions in the diametrical direction on the outer circumference of this transmission member 121, and tips of these protruded segments 110a, 110a are arranged in a face-to-face relationship with the inner peripheral surface of the buffer drum 103.

A concave portion 128 is, as illustrated in FIGS. 16 and 17, formed at the central portion of the transmission member 127 that may be also conceived as the central portion on the front end surface of the shaft 102a. In the case of the illustrative embodiment, this concave portion 128 has a spherical concave surface including its opening taking a circular shape. Accordingly, this concave portion 128 is deepest at its central area but gradually becomes shallower as it approaches the circumference.

Further, the above buffer drum 103 is, as in the same way with the conventional structure described above, formed in the cylindrical shape as a whole in such an arrangement that an outer peripheral surface of an internal sleeve 112 is connected to an inner peripheral surface of an elastic material 111 by baking

or bonding, and an inner peripheral surface of an external sleeve 113 is similarly connected to an outer peripheral surface of the elastic material 111. Then, the internal sleeve 112 is externally fixedly fitted to a cylindrical unit 114 which will be mentioned later but provided to the first yoke 104, and one half portion (a right half portion in FIG. 16) of the external sleeve 113 is internally fixed to an external cylindrical member 126 of the coupling bracket 125. In this state, the other half portion (a left half portion in FIG. 16) of the internal sleeve 112 constituting the buffer drum 103 is more protruded a bit (within a range so as not to interfere with second arms 118, 118 which will be stated later) than a front edge (a left edge in FIG. 16) of the cylindrical unit 114. In the case of this embodiment, the coupling bracket 125 is formed in a crank shape in section but a ring-like shape as a whole by performing the press-working or drawing on a metal plate such as a steel sheet, a stainless steel sheet, etc.. Then, a coupling cylindrical member 132 formed at the central portion of this coupling bracket 125 is externally fixedly fitted to the shaft 102a. Note that the coupling cylindrical member 132 is externally fitted, and, thereafter, the coupling bracket 125 is prevented from coming off by caulking part of the shaft 102a in the diametrical direction.

On the other hand, the first yoke 104 has the cylindrical unit 114 serving as an internal cylindrical unit and a pair of first arms 115 formed at one edge (a left edge in FIG. 16) of the cylindrical unit 114 in the axial direction (right-and-left directions in FIG. 16) and extending in the axial direction from face-to-face positions thereof. Then, first circular holes 116 (see FIGS. 18 and 19 illustrating a fifth embodiment which will hereinafter be discussed) are formed concentrically with each other in front edges (left edges in FIG. 16) of the respective first arms 115. Further, notches 117, 117 are respectively formed in areas off the pair of first arms 115, 115 in face-to-face positions of one edge portion of the cylindrical unit 114 in the axial direction. Dimensions of widths of these notches 117, 117 are larger than dimensions of widths of the protruded segments 110a, 110a of the transmission member 127. Then, in a state where the shaft 102a is assembled inwardly of the first yoke 104, the respective protruded segments 110a, 110a loosely engage with the insides of the notches 117, 117 with some gaps. As obvious from the above discussion as well as from FIG. 16, this engaged portion exists inward in the diametrical direction of the buffer drum 103.

Furthermore, the second yoke 105 is made by press-working, e.g., a thick metal plate and includes a pair



of second arms 118, 118 spaced away from each other.  
The thus constructed second yoke 105 is fixedly joined  
to an edge of another shaft 119 (see FIG. 13) by  
tightly fastening an unillustrated bolt. Second  
5 circular holes 120, 120 are respectively formed  
concentrically with each other in front edges (a right  
downward portion in FIG. 16) of the second arms 118,  
118. Then, four edges of the cross shaft 106 are  
rotatably supported on the internal areas of the two  
10 first and second circular holes 116, 120 formed by one  
pair through radial needle bearings 130, 130  
constructed including bearing cups 129, 129.

An operation of the thus constructed elastic  
universal joint 101a is as follows. When the  
15 automobile runs straight, or when the rotational torque  
applied to the shaft 2a from the steering wheel is  
small, the protruded segments 110a, 110a of the  
transmission member 127 fixed to the front end of the  
shaft 102a exist in neutral positions or positions  
20 deviating a bit from the neutral positions inwardly of  
the notches 117, 117 formed in the cylindrical unit 114  
of the first yoke 104. Then, in each of those states,  
the cylindrical unit 114 does not directly contact the  
transmission member 127 at all. Further, the small  
25 rotational torque is transmitted from the shaft 102a  
via the coupling bracket 125 and the buffer drum 103 to  
the first yoke 4. In this case, the elastic material

111 constituting the buffer drum 103 absorbs the vibrations transferred from the wheels to the first yoke 104 via the steering gear, another shaft 119, the second yoke 105 and the cross shaft 106, with the result that the vibrations are not transmitted to the shaft 102a. On this occasion, a magnitude of the rotational torque transferred via the coupling bracket 125 is limited.

In contrast with this, when the rotational torque applied to the shaft 102a from the steering wheel is larger as in the case of giving a large steering angle to the front wheel, the respective protruded segments 110a, 110a impinge on the inner surfaces of the notches 117, 117. As a result, a large proportion of the rotational torque applied from the steering wheel to the shaft 102a is transmitted via the transmission member 127 to the first yoke 104. In this state, the rotational torque transmitted via the buffer drum 103 is limited. Accordingly, even if the rotational torque transmitted via the elastic universal joint 101a increases, there is eliminated such a possibility that an excessive force acts on the elastic material 111 constituting the buffer drum 103, thereby preventing this elastic material 111 from being damaged.

As explained above, in the case of the elastic universal joint 101a, because of (not internally but) externally fixedly fitting the buffer drum 103 to the

cylindrical unit 114 defined as an inside cylindrical unit, the diameter of this buffer drum 103 can be sufficiently increased. In consequence, even if a hardness of the elastic material 11 constituting this  
5 buffer drum 103 is not especially enhanced, a steering stability can be improved by enhancing a torsional rigidity of the buffer drum 103. Further, there is no necessity for increasing the hardness of the elastic material 11, and hence a vibration attenuating effect  
10 by the buffer drum 103 can be well held.

Moreover, the coupling bracket 125 inclusive of the external cylindrical member 126 in which the buffer drum 103 is internally fixedly fitted transmits not a large rotational torque but only a small rotational  
15 torque irrespective of a magnitude of the rotation torque transmitted via the elastic universal joint 101a. The large rotational torque is transmitted through no intermediary of the coupling bracket 125 by making the protruded segments 110a, 110a fixedly  
20 provided at the front edge of the shaft 102a impinge on the inside surfaces of the notches 117, 117 of the cylindrical unit 114 constituting the first yoke 104. Accordingly, the coupling bracket 125 is not required to have a particularly large rigidity. For this  
25 reason, a reduction in weight of the elastic universal joint 101a can be attained by thinning the coupling bracket 125.

Further, the engaged portions between the protruded segments 110a, 110a and the notches 117, 117 exist inwardly of the buffer drum 103 in the diametrical direction thereof, and, therefore, even  
5 when a length of this buffer drum 103 in the axial direction is secured in order to ensure a mass of the elastic material 111 constituting the buffer drum 103, a length of the elastic universal joint in the axial direction does not increase, thereby attaining the  
10 reduction in weight of the elastic universal joint.

Furthermore, in the case of the illustrative embodiment, even when decreasing a distance between the front end surface of the shaft 102a and the second yoke 105 on the basis of the existence of the concave  
15 portion 128 formed in the front end surface of the shaft 102a, the front edge of the second arm 118 constituting the second yoke 105 does not interfere with the front end surface of the shaft 102a. That is, when the second yoke 105 swings about the cross shaft  
20 106, the front edge of the second arm 118 approaches the above front end surface while depicting a circular-arc locus about the cross shaft 106. The front edge described above comes closest to the front end surface, and, in this state, the central portion of the front  
25 end surface faces to the front edge. In the case of the elastic universal joint of the present invention, because of the existence of the concave portion 128 at

the central portion of the front end surface, the front end surface is hard to interfere with the front edge. Accordingly, there is not necessity for increasing a size of the first yoke 104 in order to prevent the interference, and the elastic universal joint 101a can be downsized with a smaller weight. In other words, it is possible to make the second yoke 105 approach the shaft 102a, corresponding to a depth of the concave portion 128, and the downsizing of the first yoke 104 is thereby attainable. Then, with this downsizing, an entire length of the first yoke 104 decreases, and the moldability of molding this first yoke 104 by drawing is improved, resulting in a reduction in terms of working costs.

Next, FIGS. 18 and 19 illustrate a fifth embodiment of the present invention. The fifth embodiment adopts the so-called collapsible shaft, wherein an entire length of a shaft 102b fixedly connecting the first yoke 104 to the front edge thereof (the left edge in FIG. 18) is reduced when undergoing an impact. Therefore, in accordance with the fifth embodiment, the shaft 102b is constructed so that an outer shaft 131 taking an annular tube-like shape and an inner shaft 133 assuming an annular rod-like shape are slidably combined. Accordingly, a proximal half portion (a right half portion in FIG. 18) of the outer shaft 131 has a smaller diameter than a front half

portion (a left half portion in FIG. 18), and a female  
serration groove is formed in an internal peripheral  
surface of this proximal half portion. Further, a  
front edge (a left edge in FIG. 18) of the inner shaft  
5 131 has a larger diameter than other portions, and a  
male serration groove is formed on an outer peripheral  
surface of this front edge thereof, with the result  
that the male serration groove engages with the female  
serration groove. Further, a friction adjusting member  
10 composed of a synthetic resin, etc. is provided at part  
of the engaged portion between those serration grooves  
and is formed to slide in the axial direction (right-  
and-left directions in FIG. 18) only when the engaged  
portion between the two serration grooves undergoes a  
15 large impact concomitant with an accident of collision.

In the case of this embodiment, the outer shaft  
131 constituting the front half portion of the shaft  
102b takes the annular tube-like shape, and the front  
end of this outer shaft 131 is opened to the front end  
20 surface of the shaft 102b. Accordingly, the existence  
of the internal space defined as a concave portion or a  
hole serves to prevent the interference between the  
front edge of the second arm 118 (FIG. 16) constituting  
the second yoke 105 and the front end surface of the  
25 outer shaft 131, and, correspondingly, the first yoke  
104 can be downsized with the smaller weight. Other  
configurations and operations are the same as those in

the fourth embodiment.

Next, FIGS. 20 and 21 illustrate sixth and seventh embodiments of the present invention. In both of the sixth and seventh embodiments, an external buffer drum 136 is provided between an outer peripheral surface 114 of the first yoke 104 and an inner peripheral surface of an external cylindrical member 126 of a coupling bracket 125. An internal buffer drum 127 is provided between an inner peripheral surface of the cylindrical unit 114 and an outer peripheral surface of a shaft 121. The external buffer drum 136 is disposed concentrically with the internal buffer drum 137. Thus, the external and internal buffer drums 136 and 137 are dually provided on the outer and inner peripheral sides of the cylindrical unit 114. With this arrangement, it is possible to augment volumes of the elastic materials 111, 111 per unit length that exist between the shaft 121 and the first yoke 104. Therefore, in the case of equalizing hardness of the elastic materials 111, 111 constituting the internal and external buffer drums 136, 137, the torsional rigidity can be more improved. Hence, both of the steering stability and the vibration attenuating performance can be secured at a higher level. Further, when equalizing the levels of securing the steering stability and the vibration attenuating performance, the lengths of the buffer drums 136, 137 in the axial

direction can be made smaller than in the case of providing the single buffer drum. Then, the elastic universal joint can be downsized with a smaller weight corresponding to the reductions in the lengths thereof.

5       Note that the protruded segments 110a, 110a impinge on the edge of the internal buffer drum 137, and the vibrations are prevented from being transmitted via the impingement portion in this embodiment. Therefore, a stepped portion is formed at the front end  
10 of the shaft 121, and one edge of the internal sleeve 112 constituting the internal buffer drum 137 collides against this stepped portion 134. Further, another stepped portion 135 formed in a close-to-front-end area of the intermediate portion of the shaft 121 is caulk-  
15 expanded outward in the diametrical direction, thereby regulating the other edge of the internal sleeve 112. Accordingly, this internal sleeve 112 is fixed in a predetermined position of the front end of the shaft 121. Moreover, a portion for externally fixedly  
20 fitting the external sleeve 113 is formed thinner than other portions, thereby preventing an increase in dimension of a major diameter of the portion to which this external sleeve 113 is fixed. Furthermore, the fine rugged area is formed on an outer peripheral  
25 surface of the front end of the shaft 121 by knurling, thus making an attempt to prevent a rotation of the internal sleeve 112 about this shaft 121. Other



configurations and operations are the same as those in the fourth and fifth embodiments discussed above, and hence a repetitive explanation will be omitted.

Next, FIG. 22 illustrates an eighth embodiment of the present invention. In the case of the eighth embodiment, a coupling bracket 125a is formed in substantially C-like shape in section, and a coupling cylindrical member 132 provided at its central portion is positioned inwardly of the cylindrical unit of the first yoke 104. In accordance with the eighth embodiment, the coupling cylindrical member 132 is disposed inwardly of the external cylindrical member 126. Not only this makes it possible to reduce the dimension in the axial direction, but also the coupling bracket 125a is hard to bend-deform with respect to the shaft 102b even when a bending stress is applied to the coupling bracket 125a from the buffer drum 103. That is, in the fourth through seventh embodiments discussed above, a bending center exists off the external cylindrical member 126 in the axial direction, and, hence, if the stress along the diametrical direction acts on the external cylindrical member 126, the external cylindrical member 126 is easy to deform in an inclined direction with respect to the shaft 102b on the basis of a principle of the lever. Whereas in this embodiment, the bending center exists inwardly of the external cylindrical member 126, and, therefore, the

external cylindrical member 126 is hard to deform in the inclined direction with respect to the shaft 102b. Note that the transmission member 127 is formed integrally with the shaft, but a separate transmission member may also be fixedly connected thereto afterward in each of the illustrative embodiments.

From the above it will be appreciated that in the embodiments an elastic universal joint is constructed to prevent an interference between a front end surface of a shaft and a front edge of a second arm of a second yoke irrespective of an intersecting angle between two first and second yokes without increasing a size of the first yoke. For this purpose, a concave portion is formed in the front end surface of the shaft, and, in a state where the intersecting angle between the first and second yokes increases and a front edge of the second arm approaches closest to the front end surface thereof, this front edge enters the concave portion. A distance between a cross shaft and the front end surface is reduced corresponding to a depth of the concave portion, and the first yoke is downsized with a smaller weight, correspondingly.

The elastic universal joint of the present invention is constructed and operates as described above, and it is therefore possible to attain both of securing the steering stability and the vibration

attenuating performance and reducing the weight. Furthermore, the elastic universal joint can be downsized with the smaller weight as the necessity arises.

5       It is apparent that, in this invention, a wide range of different working modes can be formed based on the invention without deviating from the spirit and scope of the invention. This invention is not restricted by its specific working modes except being  
10       limited by the appended claims.

      Attention is directed to the claims of Application No.9524528.8 (Publication No. 2296071) from which the present application is divided.

CLAIMS:

1. An elastic universal joint comprising:

a shaft;

5 a coupling bracket having its proximal end portion fixedly connected to a close-to-front-end area of an intermediate portion of said shaft;

a first yoke internally fitted and supported inwardly of an external cylindrical member provided at  
10 a front edge of said coupling bracket through a buffer drum;

a second yoke; and

a cross shaft for connecting said first and second yokes to each other,

15 wherein a protruded segment more protruded outward in a diametrical direction than an outer peripheral surface of said shaft is fixedly provided on a portion positioned inward in the diametrical direction of said buffer drum at a front end of said  
20 shaft, said protruded segment having its edge facing to an inner peripheral surface of said buffer drum,

said buffer drum is formed in a cylindrical shape including an elastic material,

said first yoke has an internal cylindrical  
25 member internally fixedly fitted in said buffer drum, a pair of first arms extending in an axial direction from face-to-face positions in a diametrical direction of one edge of said internal cylindrical member in the

axial direction, a pair of circular holes formed concentrically with each other in front edges of said first arms and notches formed at part of one edge of said internal cylindrical member in the axial  
5 direction but in areas off said pair of first arms and existing inward in the diametrical direction of said buffer drum,

said second yoke has a pair of second arms spaced away from each other and a pair of second circular  
10 holes formed concentrically with each other in front edges of said second arms,

four edges of said cross shaft are rotatably supported inwardly of said first and second circular holes respectively formed by one pairs., and

15 said protruded segment fixedly provided at the front end of said shaft is loosely engaged with said notch formed in said internal cylindrical member of said first yoke with a gap.

20 2. An elastic universal joint comprising:

a shaft;

a first yoke externally fixed fitted at a front end of said shaft through a buffer drum;

a second yoke; and

25 a cross shaft for connecting said second yoke to said first yoke,

wherein a protruded segment more protruded outward in a diametrical direction than an outer

peripheral surface of said buffer drum is fixedly provided on a portion protruding from one edge of said buffer drum at a front end of said shaft,

5       said buffer drum is formed in a cylindrical shape including an elastic material;

      said first yoke has a cylindrical member, a pair of first arms extending in an axial direction from face-to-face positions in a diametrical direction of one edge of said cylindrical member in the axial direction, a pair of circular holes formed concentrically with each other in front edges of said first arms and notches formed at one edge of said cylindrical member in the axial direction but in areas off said pair of first arms,

15       said second yoke has a pair of second arms spaced away from each other and a pair of second circular holes formed concentrically with each other in front edges of said second arms,

      four edges of said cross shaft are rotatably supported inwardly of said first and second circular holes respectively formed by one pairs,

20       said protruded segment fixedly provided at the front end of said shaft is loosely engaged with said notch formed in said cylindrical member of said first yoke with a gap, and

25       a concave portion or a hole is formed in a central portion of a front end surface of said shaft.

3. An elastic universal joint comprising:

a shaft;

5       a coupling bracket having its proximal end portion  
fixedly connected to a close-to-front-end area of an  
intermediate portion of said shaft;

10       a first yoke supported through internal and  
external buffer drums between the inside of an external  
cylindrical member provided at the front edge of said  
coupling bracket and an outer peripheral surface of the  
front end of said shaft;

a second yoke; and

15       a cross shaft for connecting said first and second  
yokes to each other,

wherein a protruded segment more protruded outward  
in a diametrical direction than an outer peripheral  
surface of said internal buffer drum is fixedly  
provided on a portion protruding from one edge of at  
20       least said internal buffer drum at a front end of said  
shaft,

said two internal and external buffer drums are  
formed in a cylindrical shape each including an elastic  
material,

25       said first yoke has an internal cylindrical  
member, a pair of first arms extending in the axial  
direction from face-to-face positions in a diametrical

direction of one edge of said internal cylindrical member in the axial direction, a pair of first circular holes formed concentrically with each other in front edges of said first arms and notches formed at part of one edge of said internal cylindrical member in the axial direction but in areas off said pair of first arms, said internal cylindrical member being internally fitted and supported inwardly of said external cylindrical member through said external buffer drum but externally fitted and supported at the front end of said shaft,

said second yoke has a pair of second arms spaced away from each other and a pair of second circular holes formed concentrically with each other in front edges of said second arms,

four edges of said cross shaft are rotatably supported inwardly of said first and second circular holes respectively formed by one pairs, and

said protruded segment fixedly provided at the front end of said shaft is loosely engaged with said notch formed in said internal cylindrical member of said first yoke with a gap.

4. A universal joint comprising first and second parts each of which comprises a yoke defining an axis of rotation, and a cross-shaft interconnecting



said yokes to allow universal relative movement therebetween, one of the parts being provided with a recess, which opens towards the other part when the axes of said yokes are aligned, for accommodating the leading edge of the yoke of the other part when said axes intersect at more than a predetermined angle to allow such intersection.

5. A universal joint substantially as herein described with reference to Figures 1 to 7, 8, 9 to 12, 16 and 17, 18 and 19, or 20 and 21 of the accompanying drawings.



Application No: GB 9807714.2  
Claims searched: 1 and 5

Examiner: C J Duff  
Date of search: 26 June 1998

**Patents Act 1977**  
**Search Report under Section 17**

**Databases searched:**

UK Patent Office collections, including GB, EP, WO & US patent specifications, in:

UK Cl (Ed.P): F2U

Int Cl (Ed.6): F16D 3/00, 3/26, 3/28, 3/50, 3/76

Other: On-line: WPI, JAPIO

**Documents considered to be relevant:**

Category	Identity of document and relevant passage	Relevant to claims
A	GB 2057632 A (NADELLA)	
A	GB 0857420 (LAYCOCK)	
A	EP 0392858 A1 (FUJI)	
A	US 5366413 (YAMAGUCHI)	
A	US 4983143 (SEKINE)	
A	US 4406640 (FRANKLIN)	
A	US 4183258 (STEPHAN)	

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